

# Week02-01

## 1、使用 GCLogAnalysis.java 自己演练一遍串行/并行/CMS/G1的案例

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miwangdeMacBook-Pro:~ XX:+PrintGCDetails GCLogAnalysis
正在执行...
[GC (Allocation Failure) [PSYoungGen: 65536K->10739K(76288K)] 65536K->21112K(251392K), 0.0097102 secs] [Times: user=0.01 sys=0.06, real=0.01 secs]
[GC (Allocation Failure) [PSYoungGen: 75947K->10744K(141924K)] 86320K->1199K(31692K), 0.0130107 secs] [Times: user=0.02 sys=0.10, real=0.02 secs]
[GC (Allocation Failure) [PSYoungGen: 141789K->10744K(141924K)] 172243K->86787K(316928K), 0.0247978 secs] [Times: user=0.03 sys=0.18, real=0.03 secs]
[GC (Allocation Failure) [PSYoungGen: 141816K->10739K(272896K)] 217059K->132815K(446400K), 0.0265568 secs] [Times: user=0.03 sys=0.20, real=0.03 secs]
[Full GC (Ergonomics) [PSYoungGen: 10739K->0K(722896K)] [ParOldGen: 121276K->120535K(355488K)] 132015K->120535K(528384K), [Metaspace: 2723K->2723K(1056768K)], 0.0146616 secs] [Times: user=0.15 sys=0.00, real=0.02 secs]
[GC (Allocation Failure) [PSYoungGen: 262144K->10750K(272896K)] 382679K->198822K(528384K), 0.0288722 secs] [Times: user=0.03 sys=0.22, real=0.03 secs]
[Full GC (Ergonomics) [PSYoungGen: 10750K->0K(272896K)] [ParOldGen: 180872K->172569K(343552K)] 198822K->172569K(616448K), [Metaspace: 2723K->2723K(1056768K)], 0.0197764 secs] [Times: user=0.23 sys=0.00, real=0.02 secs]
[GC (Allocation Failure) [PSYoungGen: 262144K->10750K(272896K)] 382679K->198822K(528384K), 0.0288722 secs] [Times: user=0.03 sys=0.22, real=0.03 secs]
[Full GC (Ergonomics) [PSYoungGen: 10750K->0K(272896K)] [ParOldGen: 180872K->172569K(343552K)] 198822K->172569K(616448K), [Metaspace: 2723K->2723K(1056768K)], 0.0197764 secs] [Times: user=0.23 sys=0.00, real=0.02 secs]
[GC (Allocation Failure) [PSYoungGen: 545516K->101879K(567296K)] 718885K->357783K(910848K), 0.0768673 secs] [Times: user=0.10 sys=0.58, real=0.08 secs]
[Full GC (Ergonomics) [PSYoungGen: 101879K->0K(567296K)] [ParOldGen: 255906K->275346K(473088K)] 357786K->275346K(1040384K), [Metaspace: 2723K->2723K(1056768K)], 0.0377709 secs] [Times: user=0.32 sys=0.08, real=0.04 secs]
[GC (Allocation Failure) [PSYoungGen: 465488K->135301K(973312K)] 749754K->410647K(1446400K), 0.0505786 secs] [Times: user=0.06 sys=0.43, real=0.06 secs]
[GC (Allocation Failure) [PSYoungGen: 947333K->170168K(590208K)] 1222679K->535398K(1463296K), 0.1019441 secs] [Times: user=0.12 sys=0.85, real=0.10 secs]
执行结束!共生成对象次数:11559
Heap
PSYoungGen   total 990208K, used 607619K [0x000000076ab00000, 0x00000007c000000, 0x00000007c000000)
eden space 812832K, 52% used [0x000000076ab00000, 0x0000000784e6278, 0x000000079c400000)
from space 178176K, 99% used [0x000000079c400000, 0x00000007a1f350, 0x00000007a1f350)
to space 240128K, 0% used [0x00000007b1580000, 0x00000007b1580000, 0x00000007b1580000)
ParOldGen   total 473088K, used 357229K [0x0000000c000000, 0x0000000d5cde0000, 0x0000000d5cde0000)
object space 473088K, 75% used [0x0000000c000000, 0x0000000d5cd4c00, 0x0000000d5cd4c00)
Metaspace    used 2729K, capacity 4486K, committed 4864K, reserved 1056768K
class space   used 298K, capacity 386K, committed 512K, reserved 1048576K
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## 串行GC

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miwangdeMacBook-Pro:~ XX:+UseSerialGC -Xms512m -Xmx512m -XX:+PrintGCDetails -XX:+PrintGCDateStamps GCLogAnalysis
正在执行...
2020-10-25T11:47:59.392-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.392-0800: [DefNew: 139776K->17472K(157248K), 0.0237975 secs] 139776K->15809K(506816K), 0.0238297 secs] [Times: user=0.01 sys=0.01, real=0.02 secs]
2020-10-25T11:47:59.437-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.438-0800: [DefNew: 157248K->17472K(157248K), 0.0311053 secs] 185585K->27272K(506816K), 0.0311385 secs] [Times: user=0.02 sys=0.01, real=0.03 secs]
2020-10-25T11:47:59.485-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.485-0800: [DefNew: 157247K->17470K(157248K), 0.0317649 secs] 227048K->135694K(506816K), 0.0317960 secs] [Times: user=0.02 sys=0.01, real=0.03 secs]
2020-10-25T11:47:59.538-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.538-0800: [DefNew: 157246K->17469K(157248K), 0.0313976 secs] 275470K->186454K(506816K), 0.0314319 secs] [Times: user=0.01 sys=0.02, real=0.03 secs]
2020-10-25T11:47:59.587-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.587-0800: [DefNew: 157245K->17473K(157248K), 0.0337902 secs] 326230K->231810K(506816K), 0.0338237 secs] [Times: user=0.02 sys=0.01, real=0.04 secs]
2020-10-25T11:47:59.642-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.642-0800: [DefNew: 157171K->17469K(157248K), 0.0304815 secs] 371510K->271362K(506816K), 0.0305258 secs] [Times: user=0.02 sys=0.02, real=0.03 secs]
2020-10-25T11:47:59.690-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.690-0800: [DefNew: 156748K->17470K(157248K), 0.0317633 secs] 410641K->312653K(506816K), 0.0318008 secs] [Times: user=0.02 sys=0.01, real=0.03 secs]
2020-10-25T11:47:59.740-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.740-0800: [DefNew: 157246K->157246K(157248K), 0.0000175 secs] 2020-10-25T11:47:59.740-0800: [Tenured: 295182K->254736K(349568K), 0.0453562 secs] 452429K->254736K(506816K), [Metaspace: 2723K->2723K(1056768K)], 0.0454297 secs] [Times: user=0.05 sys=0.05, real=0.04 secs]
2020-10-25T11:47:59.804-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.804-0800: [DefNew: 139776K->17470K(157248K), 0.0101119 secs] 394512K->301223K(506816K), 0.0101455 secs] [Times: user=0.01 sys=0.00, real=0.01 secs]
2020-10-25T11:47:59.839-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.839-0800: [DefNew: 157246K->17467K(157248K), 0.0262689 secs] 440999K->345482K(506816K), 0.0263037 secs] [Times: user=0.02 sys=0.01, real=0.03 secs]
2020-10-25T11:47:59.889-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.889-0800: [DefNew: 157243K->157243K(157248K), 0.0000165 secs] 2020-10-25T11:47:59.889-0800: [Tenured: 328014K->295658K(349568K), 0.0439660 secs] 485258K->295658K(506816K), [Metaspace: 2723K->2723K(1056768K)], 0.0444285 secs] [Times: user=0.05 sys=0.00, real=0.05 secs]
2020-10-25T11:47:59.954-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.954-0800: [DefNew: 139776K->17470K(157248K), 0.0077611 secs] 435434K->343290K(506816K), 0.0077797 secs] [Times: user=0.01 sys=0.00, real=0.01 secs]
2020-10-25T11:47:59.983-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.983-0800: [DefNew: 157246K->157246K(157248K), 0.0000157 secs] 2020-10-25T11:47:59.983-0800: [Tenured: 325819K->319738K(349568K), 0.0488703 secs] 430366K->319738K(506816K), [Metaspace: 2723K->2723K(1056768K)], 0.0449919 secs] [Times: user=0.05 sys=0.00, real=0.05 secs]
2020-10-25T11:47:59.954-0800: [GC (Allocation Failure) 2020-10-25T11:47:59.954-0800: [DefNew: 139776K->17470K(157248K), 0.0000166 secs] 2020-10-25T11:48:00.055-0800: [Tenured: 319738K->301527K(349568K), 0.0475574 secs] 495914K->301527K(506816K), [Metaspace: 2723K->2723K(1056768K)], 0.0476202 secs] [Times: user=0.05 sys=0.00, real=0.05 secs]
2020-10-25T11:48:00.125-0800: [GC (Allocation Failure) 2020-10-25T11:48:00.125-0800: [DefNew: 139760K->17471K(157248K), 0.0064420 secs] 441288K->345186K(506816K), 0.0064783 secs] [Times: user=0.01 sys=0.00, real=0.01 secs]
2020-10-25T11:48:00.152-0800: [GC (Allocation Failure) 2020-10-25T11:48:00.152-0800: [DefNew: 157246K->157246K(157248K), 0.0000173 secs] 2020-10-25T11:48:00.152-0800: [Tenured: 327714K->329864K(349568K), 0.0440969 secs] 484962K->329864K(506816K), [Metaspace: 2723K->2723K(1056768K)], 0.0441648 secs] [Times: user=0.04 sys=0.00, real=0.04 secs]
2020-10-25T11:48:00.219-0800: [GC (Allocation Failure) 2020-10-25T11:48:00.219-0800: [DefNew: 139743K->139743K(157248K), 0.0000185 secs] 2020-10-25T11:48:00.219-0800: [Tenured: 329864K->341584K(349568K), 0.0556377 secs] 496097K->341584K(506816K), [Metaspace: 2723K->2723K(1056768K)], 0.0559597 secs] [Times: user=0.06 sys=0.01, real=0.06 secs]
2020-10-25T11:48:00.294-0800: [GC (Allocation Failure) 2020-10-25T11:48:00.294-0800: [DefNew: 139776K->139776K(157248K), 0.0000390 secs] 2020-10-25T11:48:00.294-0800: [Tenured: 341584K->343629K(349568K), 0.0547483 secs] 481360K->343629K(506816K), [Metaspace: 2723K->2723K(1056768K)], 0.0548922 secs] [Times: user=0.06 sys=0.00, real=0.05 secs]
执行结束!共生成对象次数:9526
Heap
def new generation   total 157248K, used 5780K [0x00000007a000000, 0x00000007aaa0000, 0x00000007aaa0000)
eden space 139776K, 4% used [0x00000007a000000, 0x00000007a55308, 0x00000007888000)
from space 17472K, 0% used [0x000000079990000, 0x000000079990000, 0x000000079990000)
to space 17472K, 0% used [0x000000078880000, 0x000000078880000, 0x000000078880000)
tenured generation   total 349568K, used 343629K [0x00000007aaa0000, 0x00000007c000000, 0x00000007c000000)
the space 349568K, 98% used [0x00000007aaa0000, 0x00000007bfa33798, 0x00000007bfa33800, 0x00000007c000000)
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## 调大堆内存，GC时间变长，GC次数降低，运行次数也增加，运行效率提升

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miwangdeMacBook-Pro:~ XX:+UseSerialGC -Xms2048m -Xmx2048m -XX:+PrintGCDetails -XX:+PrintGCDateStamps GCLogAnalysis
正在执行...
2020-10-25T11:53:18.694-0800: [GC (Allocation Failure) 2020-10-25T11:53:18.694-0800: [DefNew: 559232K->69887K(629120K), 0.0796604 secs] 559232K->156736K(2027264K), 0.0796398 secs] [Times: user=0.04 sys=0.03, real=0.08 secs]
2020-10-25T11:53:18.842-0800: [GC (Allocation Failure) 2020-10-25T11:53:18.842-0800: [DefNew: 629119K->69887K(629120K), 0.0969097 secs] 715968K->282052K(2027264K), 0.0969409 secs] [Times: user=0.06 sys=0.05, real=0.09 secs]
2020-10-25T11:53:18.998-0800: [GC (Allocation Failure) 2020-10-25T11:53:18.998-0800: [DefNew: 629119K->69888K(629120K), 0.0779962 secs] 841284K->403015K(2027264K), 0.0780245 secs] [Times: user=0.04 sys=0.03, real=0.08 secs]
2020-10-25T11:53:19.138-0800: [GC (Allocation Failure) 2020-10-25T11:53:19.138-0800: [DefNew: 629120K->69887K(629120K), 0.0861384 secs] 962247K->526559K(2027264K), 0.0861707 secs] [Times: user=0.05 sys=0.03, real=0.09 secs]
2020-10-25T11:53:19.285-0800: [GC (Allocation Failure) 2020-10-25T11:53:19.285-0800: [DefNew: 629119K->69887K(629120K), 0.0892093 secs] 1085791K->657240K(2027264K), 0.0892411 secs] [Times: user=0.05 sys=0.03, real=0.09 secs]
2020-10-25T11:53:19.436-0800: [GC (Allocation Failure) 2020-10-25T11:53:19.436-0800: [DefNew: 629119K->69888K(629120K), 0.0734986 secs] 1216472K->777747K(2027264K), 0.0735300 secs] [Times: user=0.05 sys=0.03, real=0.07 secs]
执行结束!共生成对象次数:12633
Heap
def new generation   total 629120K, used 92234K [0x000000074000000, 0x000000076aaa0000, 0x000000076aaa0000)
eden space 559232K, 3% used [0x000000074000000, 0x000000074152b60, 0x000000076222000)
from space 69888K, 10% used [0x000000076222000, 0x0000000766650000, 0x0000000766650000)
to space 69888K, 0% used [0x0000000766650000, 0x0000000766650000, 0x000000076aa0000)
tenured generation   total 1398144K, used 707859K [0x000000076aaa0000, 0x00000007c000000, 0x00000007c000000)
the space 1398144K, 50% used [0x000000076aaa0000, 0x0000000795de400, 0x0000000795de400, 0x00000007c000000)
Metaspace    used 2729K, capacity 4486K, committed 4864K, reserved 1056768K
class space   used 298K, capacity 386K, committed 512K, reserved 1048576K
miwangdeMacBook-Pro%
```

## 并行GC (默认)

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miwangdeMacBook-Pro:~ java -XX:+UseParallelGC -Xms512m -Xmx512m -XX:+PrintGCDetails -XX:+PrintGCDateStamps GCLogAnalysis
正在执行...
2020-10-25T12:11:21.769-0800: [GC (Allocation Failure) [PSYoungGen: 131584K->21502K(153088K)] 131584K->6692K(502704K), 0.0288634 secs] [Times: user=0.03 sys=0.16, real=0.03 secs]
2020-10-25T12:11:21.814-0800: [GC (Allocation Failure) [PSYoungGen: 153087K->21502K(153088K)] 178278K->8386K(502784K), 0.0323659 secs] [Times: user=0.05 sys=0.22, real=0.03 secs]
2020-10-25T12:11:21.868-0800: [GC (Allocation Failure) [PSYoungGen: 153087K->21494K(153088K)] 215470K->125691K(502784K), 0.0247011 secs] [Times: user=0.06 sys=0.16, real=0.03 secs]
2020-10-25T12:11:21.918-0800: [GC (Allocation Failure) [PSYoungGen: 153078K->21494K(153088K)] 257275K->164975K(502784K), 0.0220348 secs] [Times: user=0.07 sys=0.14, real=0.03 secs]
2020-10-25T12:11:21.966-0800: [GC (Allocation Failure) [PSYoungGen: 153078K->21490K(153088K)] 296559K->260667K(502784K), 0.0228930 secs] [Times: user=0.08 sys=0.18, real=0.03 secs]
2020-10-25T12:11:22.017-0800: [GC (Allocation Failure) [PSYoungGen: 153074K->21502K(80838K)] 337651K->240842K(430088K), 0.0281063 secs] [Times: user=0.06 sys=0.13, real=0.02 secs]
2020-10-25T12:11:22.046-0800: [GC (Allocation Failure) [PSYoungGen: 95400K->66797K(116736K)] 320788K->285083K(466432K), 0.0138321 secs] [Times: user=0.15 sys=0.01, real=0.02 secs]
2020-10-25T12:11:22.066-0800: [GC (Allocation Failure) [PSYoungGen: 115650K->67979K(116736K)] 302788K->260692K(466432K), 0.0082980 secs] [Times: user=0.06 sys=0.01, real=0.02 secs]
2020-10-25T12:11:22.092-0800: [GC (Allocation Failure) [PSYoungGen: 81310K->22468K(116736K)] 314993K->277991K(466432K), 0.0065828 secs] [Times: user=0.07 sys=0.01, real=0.00 secs]
2020-10-25T12:11:22.120-0800: [GC (Allocation Failure) [PSYoungGen: 116659K->35785K(116736K)] 359608K->316487K(466432K), 0.0222273 secs] [Times: user=0.05 sys=0.16, real=0.02 secs]
2020-10-25T12:11:22.151-0800: [GC (Allocation Failure) [PSYoungGen: 94665K->19135K(116736K)] 375367K->332950K(466432K), 0.0281292 secs] [Times: user=0.03 sys=0.13, real=0.02 secs]
2020-10-25T12:11:22.171-0800: [Full GC (Ergonomics) [PSYoungGen: 19135K->0K(116736K)] [ParOldGen: 313814K->233593K(349696K)] 332950K->233593K(466432K), [Metaspaces: 2723K->2723K(1056768K)], 0.0540539 secs] [Times: user=0.61 sys=0.83, real=0.05 secs]
2020-10-25T12:11:22.236-0800: [GC (Allocation Failure) [PSYoungGen: 58556K->22430K(116736K)] 292158K->256023K(466432K), 0.0029880 secs] [Times: user=0.03 sys=0.01, real=0.00 secs]
2020-10-25T12:11:22.252-0800: [GC (Allocation Failure) [PSYoungGen: 81310K->22468K(116736K)] 314993K->277991K(466432K), 0.0065828 secs] [Times: user=0.07 sys=0.01, real=0.00 secs]
2020-10-25T12:11:22.270-0800: [GC (Allocation Failure) [PSYoungGen: 80914K->19170K(116736K)] 348972K->295628K(466432K), 0.0049415 secs] [Times: user=0.06 sys=0.00, real=0.00 secs]
2020-10-25T12:11:22.287-0800: [GC (Allocation Failure) [PSYoungGen: 77759K->17047K(116736K)] 354217K->311647K(466432K), 0.00874800 secs] [Times: user=0.09 sys=0.00, real=0.01 secs]
2020-10-25T12:11:22.309-0800: [GC (Allocation Failure) [PSYoungGen: 75927K->20255K(116736K)] 370527K->330689K(466432K), 0.0056891 secs] [Times: user=0.07 sys=0.00, real=0.01 secs]
2020-10-25T12:11:22.315-0800: [Full GC (Ergonomics) [PSYoungGen: 20255K->0K(116736K)] [ParOldGen: 310433K->269692K(349696K)] 330689K->269692K(466432K), [Metaspaces: 2723K->2723K(1056768K)], 0.0607628 secs] [Times: user=0.61 sys=0.81, real=0.06 secs]
2020-10-25T12:11:22.391-0800: [GC (Allocation Failure) [PSYoungGen: 58762K->20424K(116736K)] 328454K->299116K(466432K), 0.0094076 secs] [Times: user=0.11 sys=0.01, real=0.01 secs]
2020-10-25T12:11:22.412-0800: [GC (Allocation Failure) [PSYoungGen: 79280K->16156K(116736K)] 348972K->305693K(466432K), 0.0117735 secs] [Times: user=0.15 sys=0.00, real=0.01 secs]
2020-10-25T12:11:22.437-0800: [GC (Allocation Failure) [PSYoungGen: 74721K->23132K(116736K)] 364251K->328084K(466432K), 0.0088024 secs] [Times: user=0.09 sys=0.00, real=0.01 secs]
2020-10-25T12:11:22.458-0800: [GC (Allocation Failure) [PSYoungGen: 82012K->18253K(116736K)] 386884K->345493K(466432K), 0.0133401 secs] [Times: user=0.04 sys=0.07, real=0.02 secs]
2020-10-25T12:11:22.471-0800: [Full GC (Ergonomics) [PSYoungGen: 18253K->0K(116736K)] [ParOldGen: 327239K->291684K(349696K)] 345493K->291684K(466432K), [Metaspaces: 2723K->2723K(1056768K)], 0.0654535 secs] [Times: user=0.79 sys=0.02, real=0.06 secs]
2020-10-25T12:11:22.548-0800: [GC (Allocation Failure) [PSYoungGen: 58536K->23437K(116736K)] 350220K->315122K(466432K), 0.0077342 secs] [Times: user=0.08 sys=0.00, real=0.01 secs]
2020-10-25T12:11:22.572-0800: [GC (Allocation Failure) [PSYoungGen: 82317K->16868K(116736K)] 374002K->330628K(466432K), 0.0087367 secs] [Times: user=0.10 sys=0.00, real=0.01 secs]
2020-10-25T12:11:22.580-0800: [Full GC (Ergonomics) [PSYoungGen: 16868K->0K(116736K)] [ParOldGen: 313759K->298953K(349696K)] 330628K->298953K(466432K), [Metaspaces: 2723K->2723K(1056768K)], 0.0364958 secs] [Times: user=0.42 sys=0.00, real=0.03 secs]
2020-10-25T12:11:22.632-0800: [GC (Allocation Failure) [PSYoungGen: 58804K->18351K(116736K)] 377558K->317305K(466432K), 0.0026101 secs] [Times: user=0.03 sys=0.00, real=0.00 secs]
2020-10-25T12:11:22.649-0800: [GC (Allocation Failure) [PSYoungGen: 77232K->23067K(116736K)] 376185K->337798K(466432K), 0.0080061 secs] [Times: user=0.05 sys=0.00, real=0.01 secs]
2020-10-25T12:11:22.666-0800: [GC (Allocation Failure) [PSYoungGen: 81947K->18702K(116736K)] 396678K->355768K(466432K), 0.0090162 secs] [Times: user=0.04 sys=0.04, real=0.01 secs]
2020-10-25T12:11:22.675-0800: [Full GC (Ergonomics) [PSYoungGen: 18702K->0K(116736K)] [ParOldGen: 337666K->315290K(349696K)] 355768K->315290K(466432K), [Metaspaces: 2723K->2723K(1056768K)], 0.0613118 secs] [Times: user=0.71 sys=0.02, real=0.06 secs]
执行结束!共生成对象次数:7047
Heap
PSYoungGen total 116736K, used 2904K [0x00000975580000, 0x000000007C000000, 0x000000007C000000]
eden space 58880K, 4% used [0x0000000075580000, 0x000000007B5856200, 0x000000007C000000]
from space 57856K, 0% used [0x000000007B580000, 0x000000007B580000, 0x000000007C000000]
to space 57856K, 0% used [0x000000007B580000, 0x000000007B580000, 0x000000007C000000]
ParOldGen total 349696K, used 315290K [0x00000007A0000000, 0x00000007B55580000, 0x00000007B55580000]
object space 349696K, 90% used [0x00000007A0000000, 0x00000007B53365a0, 0x00000007B55580000]
Metaspaces used 2729K, capacity 4486K, committed 4864K, reserved 1056768K
```

```
miwangdeMacBook-Pro:~ java -XX:+UseParallelGC -Xms2048m -Xmx2048m -XX:+PrintGCDetails -XX:+PrintGCDateStamps GCLogAnalysis
正在执行...
2020-10-25T12:13:30.122-0800: [GC (Allocation Failure) [PSYoungGen: 524800K->87036K(611840K)] 524800K->136297K(2010112K), 0.0622539 secs] [Times: user=0.07 sys=0.48, real=0.06 secs]
2020-10-25T12:13:30.139-0800: [GC (Allocation Failure) [PSYoungGen: 611836K->16156K(611840K)] 661097K->243245K(2010112K), 0.0873933 secs] [Times: user=0.09 sys=0.66, real=0.09 secs]
2020-10-25T12:13:30.397-0800: [GC (Allocation Failure) [PSYoungGen: 611832K->87034K(611840K)] 768045K->358904K(2010112K), 0.0677021 secs] [Times: user=0.17 sys=0.44, real=0.07 secs]
2020-10-25T12:13:30.458-0800: [GC (Allocation Failure) [PSYoungGen: 611832K->87024K(611840K)] 883704K->87024K(2010112K), 0.0684435 secs] [Times: user=0.16 sys=0.45, real=0.07 secs]
2020-10-25T12:13:30.652-0800: [GC (Allocation Failure) [PSYoungGen: 611827K->87037K(611840K)] 992439K->575140K(2010112K), 0.0876457 secs] [Times: user=0.17 sys=0.38, real=0.08 secs]
2020-10-25T12:13:30.800-0800: [GC (Allocation Failure) [PSYoungGen: 611837K->87027K(320000K)] 1099940K->688574K(171827K), 0.1022104 secs] [Times: user=0.17 sys=0.37, real=0.10 secs]
执行结束!共生成对象次数:11806
Heap
PSYoungGen total 320000K, used 96844K [0x0000000795580000, 0x000000007C000000, 0x000000007C000000]
eden space 232960K, 4% used [0x00000000795580000, 0x0000000079516688, 0x000000007C000000]
from space 87040K, 99% used [0x000000007ab00000, 0x000000007bfffcc8, 0x000000007C000000]
to space 232960K, 0% used [0x000000007a3900000, 0x000000007a3900000, 0x000000007C000000]
ParOldGen total 1398272K, used 601547K [0x0000000740000000, 0x00000007b56472d10, 0x0000000795580000]
Metaspaces used 2729K, capacity 4486K, committed 4864K, reserved 1056768K
class space used 298K, capacity 386K, committed 512K, reserved 1048576K
miwangdeMacBook-Pro:~
```

注：如果去掉-Xms配置，即没有-Xms = -Xmx， 默认-Xms的配置较小时，则理论上第一次发生GC的时间会提前

## CMS

```
miwangdeMacBook-Pro:~ java -XX:+UseConcMarkSweepGC -Xms512m -Xmx512m -XX:+PrintGCDetails -XX:+PrintGCDateStamps GCLogAnalysis
正在执行...
2020-10-25T17:26:39.746-0800: [GC (Allocation Failure) 2020-10-25T17:26:39.746-0800: [ParNew: 139776K->17471K(157248K), 0.0161264 secs] 139776K->42261K(506816K), 0.0161680 secs] [Times: user=0.03 sys=0.12, real=0.02 secs]
2020-10-25T17:26:39.793-0800: [GC (Allocation Failure) 2020-10-25T17:26:39.793-0800: [ParNew: 157247K->17472K(157248K), 0.0382918 secs] 182037K->84476K(506816K), 0.0383292 secs] [Times: user=0.06 sys=0.12, real=0.04 secs]
2020-10-25T17:26:39.852-0800: [GC (Allocation Failure) 2020-10-25T17:26:39.852-0800: [ParNew: 157248K->17469K(157248K), 0.0266120 secs] 224252K->121809K(506816K), 0.0266650 secs] [Times: user=0.30 sys=0.02, real=0.02 secs]
2020-10-25T17:26:39.895-0800: [GC (Allocation Failure) 2020-10-25T17:26:39.895-0800: [ParNew: 157245K->17471K(157248K), 0.0281708 secs] 261585K->169590K(506816K), 0.0282103 secs] [Times: user=0.33 sys=0.02, real=0.03 secs]
2020-10-25T17:26:39.949-0800: [GC (Allocation Failure) 2020-10-25T17:26:39.949-0800: [ParNew: 157200K->17470K(157248K), 0.0209304 secs] 309319K->215734K(506816K), 0.0209662 secs] [Times: user=0.24 sys=0.02, real=0.03 secs]
2020-10-25T17:26:39.970-0800: [GC (CMS Initial Mark) I CMS-initial-mark: 198263K(349568K) 216289K(506816K), 0.0002429 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-25T17:26:39.972-0800: [CMS-concurrent-mark-start] [Times: user=0.01 sys=0.00, real=0.00 secs]
2020-10-25T17:26:39.972-0800: [CMS-concurrent-preclean-start] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-25T17:26:39.972-0800: [CMS-concurrent-preclean] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-25T17:26:39.972-0800: [CMS-concurrent-abortable-preclean-start] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-25T17:26:39.993-0800: [GC (Allocation Failure) 2020-10-25T17:26:39.993-0800: [ParNew: 157246K->17471K(157248K), 0.0177438 secs] 355510K->260851K(506816K), 0.0177798 secs] [Times: user=0.20 sys=0.02, real=0.02 secs]
2020-10-25T17:26:40.038-0800: [GC (Allocation Failure) 2020-10-25T17:26:40.038-0800: [ParNew: 157247K->17463K(157248K), 0.0278916 secs] 400627K->296539K(506816K), 0.0279368 secs] [Times: user=0.30 sys=0.02, real=0.03 secs]
2020-10-25T17:26:40.086-0800: [GC (Allocation Failure) 2020-10-25T17:26:40.086-0800: [ParNew: 157239K->17471K(157248K), 0.0266093 secs] 436315K->338780K(506816K), 0.0261212 secs] [Times: user=0.29 sys=0.03, real=0.03 secs]
2020-10-25T17:26:40.128-0800: [GC (Allocation Failure) 2020-10-25T17:26:40.128-0800: [ParNew: 157247K->17474K(157248K), 0.0000185 secs] 2020-10-25T17:26:40.128-0800: [CMS-current-abortable-preclean: 321309K->249774K(349568K), 0.0627480 secs] 478556K->249774K(506816K), [Metaspaces: 2723K->2723K(1056768K), 0.0628136 secs] [Times: user=0.06 sys=0.00, real=0.07 secs]
2020-10-25T17:26:40.214-0800: [GC (Allocation Failure) 2020-10-25T17:26:40.214-0800: [ParNew: 157246K->17474K(157248K), 0.0007109 secs] 309420K->295869K(506816K), 0.00071400 secs] [Times: user=0.08 sys=0.00, real=0.01 secs]
2020-10-25T17:26:40.221-0800: [GC (CMS Initial Mark) I CMS-initial-mark: 276398K(349568K) 294248K(506816K), 0.0002687 secs] [Times: user=0.01 sys=0.00, real=0.00 secs]
2020-10-25T17:26:40.222-0800: [CMS-concurrent-mark-start] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-25T17:26:40.222-0800: [CMS-concurrent-preclean-start] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-25T17:26:40.223-0800: [CMS-concurrent-preclean] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-25T17:26:40.223-0800: [CMS-concurrent-abortable-preclean-start] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-25T17:26:40.275-0800: [GC (Allocation Failure) 2020-10-25T17:26:40.275-0800: [ParNew: 157247K->157247K(157248K), 0.0000219 secs] 2020-10-25T17:26:40.275-0800: [CMS-current-abortable-preclean: 317650K->285840K(349568K), 0.0466235 secs] 474905K->285840K(506816K), [Metaspaces: 2723K->2723K(1056768K), 0.0469030 secs] [Times: user=0.05 sys=0.00, real=0.05 secs]
2020-10-25T17:26:40.341-0800: [GC (Allocation Failure) 2020-10-25T17:26:40.341-0800: [ParNew: 139776K->17470K(157248K), 0.0116367 secs] 425624K->338423K(506816K), 0.0116775 secs] [Times: user=0.14 sys=0.00, real=0.01 secs]
2020-10-25T17:26:40.353-0800: [GC (CMS Initial Mark) I CMS-initial-mark: 320952K(349568K) 341487K(506816K), 0.0003280 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-25T17:26:40.354-0800: [CMS-concurrent-mark-start] [Times: user=0.01 sys=0.00, real=0.00 secs]
2020-10-25T17:26:40.354-0800: [CMS-concurrent-mark: 0.001/0.001 secs] [Times: user=0.01 sys=0.00, real=0.00 secs]
2020-10-25T17:26:40.354-0800: [CMS-concurrent-preclean-start] [Times: user=0.00 sys=0.00, real=0.00 secs]
```

- 阶段 1: Initial Mark (初始标记)
- 阶段 2: Concurrent Mark (并发标记)
- 阶段 3: Concurrent Preclean (并发预清理)
- 阶段 4: Final Remark (最终标记)
- 阶段 5: Concurrent Sweep (并发清除)
- 阶段 6: Concurrent Reset (并发重置)

## G1

```
miwangdeMacBook-Pro% java -XX:+UseG1GC -Xms512m -Xmx512m -XX:+PrintGC -XX:+PrintGCDateStamps GCLogAnalysis
正在执行...
2020-10-25T17:49:56.185-0800: [GC pause (G1 Evacuation Pause) (young) 31M->11M(512M), 0.0038750 secs]
2020-10-25T17:49:56.196-0800: [GC pause (G1 Evacuation Pause) (young) 41M->23M(512M), 0.0044285 secs]
2020-10-25T17:49:56.237-0800: [GC pause (G1 Evacuation Pause) (young) 101M->48M(512M), 0.0104345 secs]
2020-10-25T17:49:56.262-0800: [GC pause (G1 Evacuation Pause) (young) 114M->74M(512M), 0.0116249 secs]
2020-10-25T17:49:56.429-0800: [GC pause (G1 Evacuation Pause) (young)-- 431M->323M(512M), 0.0111167 secs]
2020-10-25T17:49:56.441-0800: [GC pause (G1 Humongous Allocation) (young) (initial-mark) 325M->324M(512M), 0.0042156 secs]
2020-10-25T17:49:56.445-0800: [GC concurrent-root-region-scan-start]
2020-10-25T17:49:56.445-0800: [GC concurrent-root-region-scan-end, 0.0001404 secs]
2020-10-25T17:49:56.445-0800: [GC concurrent-mark-start]
2020-10-25T17:49:56.447-0800: [GC concurrent-mark-end, 0.0019971 secs]
2020-10-25T17:49:56.448-0800: [GC remark, 0.0013235 secs]
2020-10-25T17:49:56.449-0800: [GC cleanup 337M->336M(512M), 0.0007211 secs]
2020-10-25T17:49:56.450-0800: [GC concurrent-cleanup-start]
2020-10-25T17:49:56.450-0800: [GC concurrent-cleanup-end, 0.0000446 secs]
2020-10-25T17:49:56.472-0800: [GC pause (G1 Evacuation Pause) (young) 433M->352M(512M), 0.0072226 secs]
2020-10-25T17:49:56.482-0800: [GC pause (G1 Evacuation Pause) (mixed) 371M->311M(512M), 0.0036247 secs]
2020-10-25T17:49:56.490-0800: [GC pause (G1 Evacuation Pause) (mixed) 336M->274M(512M), 0.0037498 secs]
2020-10-25T17:49:56.500-0800: [GC pause (G1 Evacuation Pause) (mixed) 300M->243M(512M), 0.0041234 secs]
2020-10-25T17:49:56.508-0800: [GC pause (G1 Evacuation Pause) (mixed) 270M->233M(512M), 0.0035210 secs]
2020-10-25T17:49:56.512-0800: [GC pause (G1 Humongous Allocation) (young) (initial-mark) 235M->234M(512M), 0.0017653 secs]
2020-10-25T17:49:56.513-0800: [GC concurrent-root-region-scan-start]
2020-10-25T17:49:56.514-0800: [GC concurrent-root-region-scan-end, 0.0001001 secs]
2020-10-25T17:49:56.514-0800: [GC concurrent-mark-start]
2020-10-25T17:49:56.514-0800: [GC concurrent-mark-end, 0.0007155 secs]
2020-10-25T17:49:56.514-0800: [GC remark, 0.0012602 secs]
2020-10-25T17:49:56.516-0800: [GC cleanup 241M->241M(512M), 0.0008295 secs]
2020-10-25T17:49:56.552-0800: [GC pause (G1 Evacuation Pause) (young)-- 424M->349M(512M), 0.0049008 secs]
2020-10-25T17:49:56.558-0800: [GC pause (G1 Evacuation Pause) (mixed) 354M->330M(512M), 0.0053881 secs]
2020-10-25T17:49:56.564-0800: [GC pause (G1 Humongous Allocation) (young) (initial-mark) 333M->331M(512M), 0.0016126 secs]
2020-10-25T17:49:56.566-0800: [GC concurrent-root-region-scan-start]
2020-10-25T17:49:56.566-0800: [GC concurrent-root-region-scan-end, 0.0001353 secs]
2020-10-25T17:49:56.566-0800: [GC concurrent-mark-start]
2020-10-25T17:49:56.567-0800: [GC concurrent-mark-end, 0.00009443 secs]
2020-10-25T17:49:56.567-0800: [GC remark, 0.0013086 secs]
2020-10-25T17:49:56.568-0800: [GC cleanup 337M->335M(512M), 0.0008460 secs]
2020-10-25T17:49:56.569-0800: [GC concurrent-cleanup-start]
2020-10-25T17:49:56.569-0800: [GC concurrent-cleanup-end, 0.0000157 secs]
2020-10-25T17:49:56.586-0800: [GC pause (G1 Evacuation Pause) (young) 416M->355M(512M), 0.0037636 secs]
2020-10-25T17:49:56.595-0800: [GC pause (G1 Evacuation Pause) (mixed) 378M->314M(512M), 0.0051057 secs]
2020-10-25T17:49:56.605-0800: [GC pause (G1 Evacuation Pause) (mixed) 342M->287M(512M), 0.0055478 secs]
2020-10-25T17:49:56.615-0800: [GC pause (G1 Evacuation Pause) (mixed) 312M->281M(512M), 0.0033560 secs]
2020-10-25T17:49:56.618-0800: [GC pause (G1 Humongous Allocation) (young) (initial-mark) 283M->282M(512M), 0.0016305 secs]
2020-10-25T17:49:56.620-0800: [GC concurrent-root-region-scan-start]
2020-10-25T17:49:56.620-0800: [GC concurrent-root-region-scan-end, 0.0000885 secs]
```

Evacuation Pause: young (纯年轻代模式转移暂停)

Concurrent Marking (并发标记)

阶段 1: Initial Mark (初始标记)

阶段 2: Root Region Scan (Root区扫描)

阶段 3: Concurrent Mark (并发标记)

阶段 4: Remark (再次标记)

阶段 5: Cleanup (清理)

Evacuation Pause (mixed) (转移暂停: 混合模式)

Full GC (Allocation Failure)

```

miwangdeMacBook-Pro% java -XX:+UseG1GC -Xms4g -Xmx4g -XX:+PrintGC -XX:+PrintGCDateStamps GCLogAnalysis
正在执行...
2020-10-25T17:54:35.378-0800: [GC pause (G1 Evacuation Pause) (young) 204M->66M(4096M), 0.0267589 secs]
2020-10-25T17:54:35.438-0800: [GC pause (G1 Evacuation Pause) (young) 244M->123M(4096M), 0.0248131 secs]
2020-10-25T17:54:35.495-0800: [GC pause (G1 Evacuation Pause) (young) 301M->182M(4096M), 0.0307278 secs]
2020-10-25T17:54:35.554-0800: [GC pause (G1 Evacuation Pause) (young) 360M->239M(4096M), 0.0264649 secs]
2020-10-25T17:54:35.612-0800: [GC pause (G1 Evacuation Pause) (young) 417M->298M(4096M), 0.0292221 secs]
2020-10-25T17:54:35.669-0800: [GC pause (G1 Evacuation Pause) (young) 476M->350M(4096M), 0.0236025 secs]
2020-10-25T17:54:35.724-0800: [GC pause (G1 Evacuation Pause) (young) 528M->420M(4096M), 0.0328691 secs]
2020-10-25T17:54:35.784-0800: [GC pause (G1 Evacuation Pause) (young) 598M->473M(4096M), 0.0239924 secs]
2020-10-25T17:54:35.856-0800: [GC pause (G1 Evacuation Pause) (young) 711M->548M(4096M), 0.0408531 secs]
2020-10-25T17:54:35.941-0800: [GC pause (G1 Evacuation Pause) (young) 826M->629M(4096M), 0.0441648 secs]
2020-10-25T17:54:36.029-0800: [GC pause (G1 Evacuation Pause) (young) 949M->723M(4096M), 0.0774249 secs]
2020-10-25T17:54:36.153-0800: [GC pause (G1 Evacuation Pause) (young) 1057M->812M(4096M), 0.1136393 secs]
执行结束!共生成对象次数:10169

```

## 不同GC的总结(使用多次平均值进行统计)

|     | <b>-Xmx512m - Xms512m</b>               | <b>-Xmx1g -Xms1g</b>                    | <b>-Xmx2g - Xms2g</b>     | <b>-Xmx4g - Xms4g</b>     |
|-----|---|---|---------------------------|---------------------------|
| 串行  | 生成对象次数:7942, youngGC平均14次               | 生成对象次数:9488, youngGC平均9次                | 生成对象次数:10097, youngGC平均4次 | 生成对象次数:8455, youngGC平均2次  |
| 并行  | 生成对象次数:7023, 执行FullGC 5次, YoungGC 24次左右 | 生成对象次数:8430, 执行FullGC 1次, YoungGC 12次左右 | 生成对象次数:9851, youngGC平均5次  | 生成对象次数:7757, youngGC平均2次  |
| CMS | 生成对象次数:8933, 执行FullGC 次, YoungGC 27次左右  | 生成对象次数:9411, 执行FullGC 1次, YoungGC 9次左右  | 生成对象次数:10460, youngGC平均5次 | 生成对象次数:10022, youngGC平均3次 |
| G1  | 生成对象次数:8319                             | 生成对象次数:8978                             | 生成对象次数:9633               | 生成对象次数:9310               |

感觉内存存在2g后，增加内存，产生对象数量反而有所下降

## 2、使用压测工具（wrk或sb），演练gateway-server-0.0.1-SNAPSHOT.jar示例

```

miwangdeMacBook-Pro% wrk -t16 -c200 -d60s http://127.0.0.1:8088/api/hello
Running 1m test @ http://127.0.0.1:8088/api/hello
  16 threads and 200 connections
Thread Stats      Avg      Stdev     Max   +/- Stdev
  Latency    8.80ms   42.56ms  576.58ms   96.71%
  Req/Sec    5.49k    1.22k   11.81k   86.21%
  3301500 requests in 1.00m, 394.17MB read
  Socket errors: connect 0, read 111, write 0, timeout 0
Requests/sec:  54935.40
Transfer/sec:    6.56MB
miwangdeMacBook-Pro%

```

wrk各项参数说明：

Latency: 响应时间

Req/Sec: 单个线程处理请求数

Avg:平均值

Stdev:标准差，值越大说明数据分布均匀，可能是机器或服务性能不稳定导致。

Max:最大值

+/- Stdev: 正负标准差比例，差值比标准差大或小的数据比率

Latency Distribution: 延时分布多少ms一下请求数比例

Requests/sec: 平均每秒处理请求数

Transfer/sec: 平均每秒传输数据量

执行命令wrk -t16 -c200 -d60s <http://127.0.0.1:8088/api/hello>

|         | Avg(512m) | Stdev(512m) | Max(512m) | Avg(1g) | Stdev(1g) | Max(1g)  | Avg(2g) | Stdev(2g) | Max(2g)  |
|---------|-----------|-------------|-----------|---------|-----------|----------|---------|-----------|----------|
| Latency | 11.23ms   | 42.36ms     | 451.39ms  | 9.39ms  | 35.61ms   | 462.37ms | 5.71ms  | 23.82ms   | 418.44ms |
| Req/Sec | 4.29k     | 1.42k       | 10.17k    | 4.61k   | 1.78k     | 13.15k   | 4.75k   | 1.43k     | 14.00k   |

相同GC下，内存增大，延时和吞吐都会变好