

1.使用串行 GC 不调堆大小的情况下

```
2. ./gradlew :Week2:java -XX:+UseSerialGC -XX:+PrintGCDetails -XX:+PrintGCTimeStamps -Xlog:gcanalysis:debug
正在执行...
0.162: [GC (Allocation Failure) 0.162: [DefNew: 67712K->8448K(76160K), 0.0082211 secs] 67712K->23523K(245040K), 0.008371 secs] [Times: user=0.03 sys=0.00, real=0.01 secs]
0.164: [GC (Allocation Failure) 0.164: [DefNew: 76066K->8448K(76160K), 0.0070739 secs] 8112K->47460K(245040K), 0.010112 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.169: [GC (Allocation Failure) 0.169: [DefNew: 76070K->8448K(76160K), 0.0074883 secs] 115168K->36322K(245040K), 0.007850 secs] [Times: user=0.00 sys=0.02, real=0.01 secs]
0.170: [GC (Allocation Failure) 0.170: [DefNew: 76147K->8448K(76160K), 0.0085334 secs] 136344K->34422K(245040K), 0.008250 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.189: [GC (Allocation Failure) 0.189: [DefNew: 76153K->8444K(76160K), 0.0086831 secs] 32224K->11502K(245040K), 0.007753 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.205: [GC (Allocation Failure) 0.205: [DefNew: 76156K->8448K(76160K), 0.0079017 secs] 32763K->12833K(245040K), 0.0082537 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.222: [GC (Allocation Failure) 0.222: [DefNew: 76152K->8438K(76160K), 0.0083302 secs] 36654K->36368K(245040K), 0.008304 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.241: [GC (Allocation Failure) 0.241: [DefNew: 76066K->8447K(76160K), 0.0084740 secs] 0.250: [Tenured: 179432K->166368K(179444K), 0.0171322 secs] 23121K->166368K(255040K), [Metaspace: 2653K->2653K(1056768K)], 0.0264494 secs] [Times: user=0.02 sys=0.00, real=0.03 secs]
0.257: [GC (Allocation Failure) 0.257: [DefNew: 11856K->13323K(124864K), 0.0097294 secs] 27224K->206740K(402148K), 0.0099709 secs] [Times: user=0.02 sys=0.00, real=0.01 secs]
0.310: [GC (Allocation Failure) 0.310: [DefNew: 124817K->13323K(124864K), 0.0135754 secs] 317736K->242242K(402148K), 0.013784 secs] [Times: user=0.02 sys=0.00, real=0.01 secs]
0.341: [GC (Allocation Failure) 0.342: [DefNew: 124891K->13323K(124864K), 0.0116366 secs] 33292K->277244K(402148K), 0.012974 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.371: [GC (Allocation Failure) 0.371: [DefNew: 124863K->13323K(124864K), 0.0124345 secs] 0.383: [Tenured: 298327K->246757K(298900K), 0.0277787 secs] 38328K->246757K(423764K), [Metaspace: 2653K->2653K(1056768K)], 0.0410938 secs] [Times: user=0.03 sys=0.01, real=0.04 secs]
0.439: [GC (Allocation Failure) 0.439: [DefNew: 164038K->20543K(185152K), 0.0101906 secs] 410796K->301557K(596416K), 0.010511 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.474: [GC (Allocation Failure) 0.474: [DefNew: 185151K->20543K(185152K), 0.0184148 secs] 466168K->357761K(596416K), 0.0189949 secs] [Times: user=0.00 sys=0.01, real=0.02 secs]
0.515: [GC (Allocation Failure) 0.515: [DefNew: 185151K->20543K(185152K), 0.0167370 secs] 52229K->48470K(596416K), 0.017194 secs] [Times: user=0.00 sys=0.02, real=0.02 secs]
0.555: [GC (Allocation Failure) 0.555: [DefNew: 18512K->20544K(185152K), 0.0196051 secs] 0.575: [Tenured: 44530K->322781K(445728K), 0.0369229 secs] 569288K->322781K(630880K), [Metaspace: 2653K->2653K(1056768K)], 0.0573659 secs] [Times: user=0.05 sys=0.02, real=0.08 secs]
0.644: [GC (Allocation Failure) 0.645: [DefNew: 215232K->26878K(242112K), 0.0129705 secs] 538013K->390530K(78084K), 0.0133035 secs] [Times: user=0.02 sys=0.00, real=0.01 secs]
0.674: [GC (Allocation Failure) 0.689: [DefNew: 242110K->26878K(242112K), 0.0154657 secs] 606762K->45436K(78084K), 0.0158842 secs] [Times: user=0.02 sys=0.00, real=0.02 secs]
0.726: [GC (Allocation Failure) 0.726: [DefNew: 242105K->26878K(242112K), 0.0111389 secs] 66698K->71148K(78084K), 0.0186353 secs] [Times: user=0.02 sys=0.00, real=0.02 secs]
0.785: [GC (Allocation Failure) 0.786: [DefNew: 242111K->26878K(242112K), 0.0218401 secs] 0.808: [Tenured: 558993K->352440K(559032K), 0.0457827 secs] 732718K->352440K(801144K), [Metaspace: 2653K->2653K(1056768K)], 0.0683842 secs] [Times: user=0.06 sys=0.00, real=0.07 secs]
0.888: [GC (Allocation Failure) 0.889: [DefNew: 23500K->29378K(264384K), 0.0145472 secs] 587448K->431728K(861728K), 0.0151134 secs] [Times: user=0.02 sys=0.00, real=0.01 secs]
0.924: [GC (Allocation Failure) 0.937: [DefNew: 26438K->29378K(264384K), 0.0122522 secs] 66676K->76134K(861728K), 0.0125713 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.983: [GC (Allocation Failure) 0.984: [DefNew: 26432K->29378K(264384K), 0.0123868 secs] 73637K->54969K(861728K), 0.012377 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
1.030: [GC (Allocation Failure) 1.031: [DefNew: 26432K->29378K(264384K), 0.0109645 secs] 1.051: [Tenured: 607540K->402802K(607544K), 0.0429547 secs] 804968K->402802K(871948K), [Metaspace: 2653K->2653K(1056768K)], 0.0638025 secs] [Times: user=0.05 sys=0.02, real=0.09 secs]
运行结果: 共生成对象数: 13038
heap
def new generation total 302144K, used 19855K [0x00000006e9400000, 0x00000006adb40000, 0x000000071b800000]
 eden space 268608K, 4% used [0x00000006e9400000, 0x00000006e94a0000, 0x00000006adb40000]
  from space 23538K, 0% used [0x00000006adb40000, 0x00000006adb45000, 0x00000006adb45000]
 to space 25536K, 0% used [0x00000006adb10000, 0x00000006adb10000, 0x00000006adb40000]
 tenured generation total 87132K, used 42802K [0x000000071b800000, 0x000000071b800000, 0x000000071b800000]
  the space 87132K, 49% used [0x000000071b800000, 0x000000071b800000, 0x000000071b800000]
  free space 44330K, capacity 44330K, committed 44330K, reserved 105760K
Metaspace used 2653K, capacity 480K, committed 480K, reserved 105760K
class space used 257K, capacity 384K, committed 512K, reserved 1048576K
```

完整分析：

一共生成了 13038 个对象，一共进行了 24 次 GC 操作，其中 5 次 MoajorGC，19 次 MinorGC，GC 引起的原因都是没有足够的内存存储新数据。

分步分析（以第一次 MoajorGC 为例）：

0.241s：

第一次执行 MoajorGC 的时间是在程序运行到 0.241s 处

GC:

SerialGC 执行，表示进行了一次 GC

DefNew:

串行 GC 新生代使用的回收算法

76066K->8447K(76160K):

表示新生代从 76066K 减少到 8447K，新生代的使用率从 99%减少到 11%

0.0084740 secs:

这个区域的 GC 一共使用了 0.0084740s，相当于 8ms

0.250:

在 0.250 这个时刻开始执行 Tenured 进行老年代回收

Tenured:

串行 GC 老年代使用算法

179432K->166368K(179444K):

老年代的大小从 179432K 减少到 166368K，使用率从接近 100%减少到 92%

0.0171322 secs:

消耗了 0.0171322s, 相当于 17ms

231214K->166368K(255604K):

表示整个堆的使用从 231214K 减少到 166368K, 堆使用率从 90%减少到 65%, 我们通过计算可以看到其中有 2773k 的数据从年轻代升级到老年代

Metaspace:

Meta 区 GC 执行

2653K->2653K(1056768K):

Meta 区数据没变化

0.0264494 secs:

Meta 区 GC 一共消耗 26ms

Times: user=0.03 sys=0.00, real=0.03 secs:

用户态消耗 30ms, 内核态没有消耗, 真实时间为 30ms

总结:

串行 GC 执行一次时间较长, 而且无论 MinorGC 还是 FullGC 都会导致 STW, 而且随着内存的增大, GC 的时间也在不断的增加, 回收效率也较低

2.使用串行 GC 调堆内存大小

```
PS C:\Program Files\Java\jdk-9.0.4> java XX\UseSerialGC %*512m XX\PrintGCDetails XX\PrintGCTimeStamps GCLogAnalysis
正在执行...
0.126: GC (Allocation Failure) 0.126: [DefNew: 139776K->17471K(157248K), 0.0154317 secs] [Times: user=0.00 sys=0.01, real=0.01 secs]
0.146: GC (Allocation Failure) 0.146: [DefNew: 157036K->17471K(157248K), 0.0201117 secs] [Times: user=0.02 sys=0.02, real=0.02 secs]
0.207: GC (Allocation Failure) 0.207: [DefNew: 157247K->17471K(157248K), 0.0145955 secs] [Times: user=0.02 sys=0.00, real=0.02 secs]
0.241: GC (Allocation Failure) 0.242: [DefNew: 157247K->17471K(157248K), 0.0150001 secs] [Times: user=0.00 sys=0.01, real=0.02 secs]
0.276: GC (Allocation Failure) 0.276: [DefNew: 157048K->17471K(157248K), 0.0147110 secs] [Times: user=0.00 sys=0.02, real=0.02 secs]
0.311: GC (Allocation Failure) 0.312: [DefNew: 157247K->17471K(157248K), 0.0159909 secs] [Times: user=0.00 sys=0.02, real=0.01 secs]
0.345: GC (Allocation Failure) 0.345: [DefNew: 157247K->17471K(157248K), 0.0152945 secs] [Times: user=0.02 sys=0.00, real=0.02 secs]
0.380: GC (Allocation Failure) 0.380: [DefNew: 156967K->15697K(157248K), 0.0001092 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.420: GC (Allocation Failure) 0.420: [DefNew: 139776K->17471K(157248K), 0.0064220 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.464: GC (Allocation Failure) 0.464: [DefNew: 157247K->17471K(157248K), 0.0122084 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.487: GC (Allocation Failure) 0.488: [DefNew: 157247K->157247K(157248K), 0.0001488 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.545: GC (Allocation Failure) 0.545: [DefNew: 139776K->139776K(157248K), 0.0001214 secs] [Times: user=0.00 sys=0.00, real=0.04 secs]
0.603: GC (Allocation Failure) 0.603: [DefNew: 139776K->139776K(157248K), 0.0001214 secs] [Times: user=0.00 sys=0.00, real=0.04 secs]
0.661: GC (Allocation Failure) 0.662: [DefNew: 139776K->17471K(157248K), 0.0066226 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
0.688: GC (Allocation Failure) 0.689: [DefNew: 157143K->157143K(157248K), 0.0002259 secs] [Times: user=0.00 sys=0.00, real=0.04 secs]
0.744: GC (Allocation Failure) 0.744: [DefNew: 139743K->139743K(157248K), 0.0001194 secs] [Times: user=0.00 sys=0.00, real=0.04 secs]
0.802: GC (Allocation Failure) 0.802: [DefNew: 139743K->139743K(157248K), 0.0001194 secs] [Times: user=0.00 sys=0.00, real=0.04 secs]
0.864: Full GC (Allocation Failure) 0.864: [Tenured: 249548K->249517K(349568K), 0.0440793 secs] [Times: user=0.00 sys=0.00, real=0.05 secs]
0.928: GC (Allocation Failure) 0.928: [DefNew: 139776K->139776K(157248K), 0.0001223 secs] [Times: user=0.00 sys=0.00, real=0.04 secs]
0.979: Full GC (Allocation Failure) 0.979: [Tenured: 249558K->249548K(349568K), 0.0329219 secs] [Times: user=0.03 sys=0.00, real=0.04 secs]
1.036: Full GC (Allocation Failure) 1.036: [Tenured: 249548K->249446K(349568K), 0.0410267 secs] [Times: user=0.03 sys=0.00, real=0.04 secs]
执行结束! 共生成对象数:11179
def new generation total 157248K, used 29647K [0x00000000a0000000, 0x00000000aaa00000, 0x00000000aaa00000]
eden space 129776K, 21% used [0x00000000a0000000, 0x00000000a1f568, 0x00000000a2800000]
from space 17472K, 0% used [0x00000000a2800000, 0x00000000a2800000, 0x00000000a9900000]
to space 17472K, 0% used [0x00000000a9900000, 0x00000000a9900000, 0x00000000aaa00000]
tenured generation total 349568K, used 349446K [0x00000000aaa00000, 0x0000000010000000, 0x0000000010000000]
new space 249568K, 2% used [0x00000000aaa00000, 0x00000000bff1e138, 0x00000000bff1e1a0, 0x0000000010000000]
Metaspace used 2653K, capacity 4489K, committed 4054K, reserved 1056768K
class space used 207K, capacity 288K, committed 512K, reserved 1048576K
```

分析:

此时出现了 FullGC, 而且约到之行的最后 FullGC 执行的越频繁, 这对于系统是很不友好的, 因为频繁的 FullGC 会大量产生 STW, 会导致系统出现很严重的卡顿, 而且还不一定能回收多少数据。

3.使用 ParallelGC 的情况下

```
GC heap dump: java -XX:-PrintGCDetails -XX:-PrintGCTimeStamps GLogAnalysis
正在执行...
0.103: GC (Allocation Failure) [PSTonGen: 64000K->10234K(74240K)] 64000K->24424K(243712K), 0.004691 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.116: GC (Allocation Failure) [PSTonGen: 7423K->10234K(13244K)] 88424K->46112K(30712K), 0.006184 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.137: GC (Allocation Failure) [PSTonGen: 38224K->10234K(13244K)] 174112K->38968K(43772K), 0.007540 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.158: GC (Allocation Failure) [PSTonGen: 13780K->10234K(26624K)] 211588K->12837K(435712K), 0.0074361 sec [Times: user=0.03 sys=0.17, real=0.01 sec]
0.143: GC (Allocation Failure) [PSTonGen: 56623K->10234K(26624K)] 218172K->29430K(46080K), 0.013290 sec [Times: user=0.03 sys=0.17, real=0.01 sec]
0.256: Full GC (Ergonomics) [PSTonGen: 10234K->0K(0K+24K)] [ParOldGen: 18396K->17458K(13244K)] 24424K->7463K(30615K), [Metaspace: 263K->263K(105768K)], 0.0180714 sec [Times: user=0.20 sys=0.00, real=0.02 sec]
0.211: GC (Allocation Failure) [PSTonGen: 25579K->8197K(52512K)] 430785K->25696K(862208K), 0.011107 sec [Times: user=0.08 sys=0.13, real=0.01 sec]
0.286: GC (Allocation Failure) [PSTonGen: 64576K->12502K(52056K)] 49943K->22608K(91832K), 0.022449 sec [Times: user=0.00 sys=0.23, real=0.00 sec]
0.429: Full GC (Ergonomics) [PSTonGen: 10290K->0K(53256K)] [ParOldGen: 24972K->26849K(46048K)] 32568K->26849K(105139K), [Metaspace: 263K->263K(105768K)], 0.025214 sec [Times: user=0.20 sys=0.00, real=0.03 sec]
0.565: GC (Allocation Failure) [PSTonGen: 47974K->13572K(60912K)] 74524K->40425K(137772K), 0.012728 sec [Times: user=0.00 sys=0.19, real=0.02 sec]
0.639: GC (Allocation Failure) [PSTonGen: 88828K->17561K(62928K)] 115235K->62913K(132650K), 0.032310 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.181: GC (Allocation Failure) [PSTonGen: 75292K->3444K(7616K)] 0.0084671 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.765: GC (Allocation Failure) [PSTonGen: 92671K->22750K(99942K)] 127786K->63748K(146794K), 0.034800 sec [Times: user=0.19 sys=0.42, real=0.04 sec]
0.830: Full GC (Ergonomics) [PSTonGen: 27067K->0K(99744K)] [ParOldGen: 49139K->26958K(94452K)] 63748K->34694K(103264K), [Metaspace: 263K->263K(105768K)], 0.0341792 sec [Times: user=0.38 sys=0.00, real=0.04 sec]
0.863: GC (Allocation Failure) [PSTonGen: 76185K->19563K(56762K)] 117284K->56160K(152384K), 0.014910 sec [Times: user=0.20 sys=0.00, real=0.02 sec]
执行结束! 共生成对象次数: 17911
PSTonGen: total 957952K, used 848092K [0x000000076d:00000, 0x000000077c:0000000, 0x000000077d:0000000]
eden space 76185K, 28% used [0x000000076d:00000, 0x000000077c:0000000, 0x000000077d:0000000]
from space 19609K, 99% used [0x00000007b:40000, 0x00000007c330a8:0, 0x00000007c330000]
to space 30412K, 0% used [0x000000077c:00000, 0x000000077d:00000, 0x000000077e:00000]
ParOldGen: total 94424K, used 26766K [0x00000008:040000, 0x00000008e88000, 0x000000076d:00000]
object space 594432K, 61% used [0x00000008e8:040000, 0x00000008e8:04000, 0x00000008e8:00000]
Metaspace: used 263K, capacity 408K, committed 408K, reserved 105768K
class space used 297K, capacity 386K, committed 512K, reserved 1048576K
```

分析:

没有规定堆大小的情况下，默认堆大小为 1.5G 左右，一共生成了 17911 个对象，对比 SerialGC，多生成了 1/3 的对象，内存结构被更好的优化，使用的新生代算法为 PSYoungGen，老年代算法为 ParOldGen，虽然并行 GC 两次都会导致 STW，但是整体来看还是比串行快很多。

4.使用 CMS 的情况下

```
GC heap dump: java -XX:-UseConcMarkSweepGC -XX:-PrintGCDetails -XX:-PrintGCTimeStamps GLogAnalysis
正在执行...
0.103: GC (Allocation Failure) [0.103: ParNew: 67712K->32182K(245504K)] 0.004199 sec [Times: user=0.05 sys=0.17, real=0.00 sec]
0.116: GC (Allocation Failure) [0.116: ParNew: 7615K->3444K(7616K)] 0.005206 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.137: GC (Allocation Failure) [0.137: ParNew: 7615K->3444K(7616K)] 0.005205 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.158: GC (Allocation Failure) [0.158: ParNew: 75292K->3444K(7616K)] 0.0084671 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.143: GC (Allocation Failure) [0.143: ParNew: 7615K->3444K(7616K)] 0.005202 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.256: GC (CMS Initial Mark) [1 CMS-initial-mark: 10250K(169344K)] 11250K(245504K), 0.0006913 sec [Times: user=0.00 sys=0.00, real=0.00 sec]
0.196: GC (CMS concurrent-mark-start) [Times: user=0.00 sys=0.00, real=0.00 sec]
0.196: GC (CMS concurrent-mark) [0.02/0.001 sec] [Times: user=0.00 sys=0.00, real=0.00 sec]
0.196: GC (CMS concurrent-preclean-start) [Times: user=0.00 sys=0.00, real=0.00 sec]
0.197: GC (CMS concurrent-preclean) [0.00/0.001 sec] [Times: user=0.00 sys=0.00, real=0.00 sec]
0.197: GC (CMS concurrent-abortable-preclean-start) [Times: user=0.00 sys=0.00, real=0.00 sec]
0.197: GC (Allocation Failure) [0.197: ParNew: 7615K->3444K(7616K)] 0.005206 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.219: GC (Allocation Failure) [0.219: ParNew: 7615K->3444K(7616K)] 0.005206 sec [Times: user=0.19 sys=0.01, real=0.01 sec]
0.230: GC (Allocation Failure) [0.230: ParNew: 75292K->3444K(7616K)] 0.005213 sec [Times: user=0.19 sys=0.02, real=0.01 sec]
0.239: GC (Allocation Failure) [0.239: ParNew: 7615K->3444K(7616K)] 0.005195 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.278: GC (Allocation Failure) [0.278: ParNew: 75292K->3444K(7616K)] 0.009722 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.286: GC (Allocation Failure) [0.286: ParNew: 7615K->3444K(7616K)] 0.005197 sec [Times: user=0.00 sys=0.00, real=0.01 sec]
0.317: GC (Allocation Failure) [0.317: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.335: GC (Allocation Failure) [0.335: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.354: GC (Allocation Failure) [0.354: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.374: GC (Allocation Failure) [0.374: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.385: GC (Allocation Failure) [0.385: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.414: GC (Allocation Failure) [0.414: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.433: GC (Allocation Failure) [0.433: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.451: GC (Allocation Failure) [0.451: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.470: GC (Allocation Failure) [0.470: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.489: GC (Allocation Failure) [0.489: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.508: GC (Allocation Failure) [0.508: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.527: GC (Allocation Failure) [0.527: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.546: GC (Allocation Failure) [0.546: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.565: GC (Allocation Failure) [0.565: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.584: GC (Allocation Failure) [0.584: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.603: GC (Allocation Failure) [0.603: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.622: GC (Allocation Failure) [0.622: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.641: GC (Allocation Failure) [0.641: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.660: GC (Allocation Failure) [0.660: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.679: GC (Allocation Failure) [0.679: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.698: GC (Allocation Failure) [0.698: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.717: GC (Allocation Failure) [0.717: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.736: GC (Allocation Failure) [0.736: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.755: GC (Allocation Failure) [0.755: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.774: GC (Allocation Failure) [0.774: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.793: GC (Allocation Failure) [0.793: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.812: GC (Allocation Failure) [0.812: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.831: GC (Allocation Failure) [0.831: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.850: GC (Allocation Failure) [0.850: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.869: GC (Allocation Failure) [0.869: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.888: GC (Allocation Failure) [0.888: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.907: GC (Allocation Failure) [0.907: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.926: GC (Allocation Failure) [0.926: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.945: GC (Allocation Failure) [0.945: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.964: GC (Allocation Failure) [0.964: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.983: GC (Allocation Failure) [0.983: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1002: GC (Allocation Failure) [0.1002: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1021: GC (Allocation Failure) [0.1021: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1040: GC (Allocation Failure) [0.1040: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1059: GC (Allocation Failure) [0.1059: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1078: GC (Allocation Failure) [0.1078: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1097: GC (Allocation Failure) [0.1097: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1116: GC (Allocation Failure) [0.1116: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1135: GC (Allocation Failure) [0.1135: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1154: GC (Allocation Failure) [0.1154: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1173: GC (Allocation Failure) [0.1173: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1192: GC (Allocation Failure) [0.1192: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1211: GC (Allocation Failure) [0.1211: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1230: GC (Allocation Failure) [0.1230: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1249: GC (Allocation Failure) [0.1249: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1268: GC (Allocation Failure) [0.1268: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1287: GC (Allocation Failure) [0.1287: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1306: GC (Allocation Failure) [0.1306: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1325: GC (Allocation Failure) [0.1325: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1344: GC (Allocation Failure) [0.1344: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1363: GC (Allocation Failure) [0.1363: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1382: GC (Allocation Failure) [0.1382: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1401: GC (Allocation Failure) [0.1401: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1420: GC (Allocation Failure) [0.1420: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1439: GC (Allocation Failure) [0.1439: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1458: GC (Allocation Failure) [0.1458: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1477: GC (Allocation Failure) [0.1477: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1496: GC (Allocation Failure) [0.1496: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1515: GC (Allocation Failure) [0.1515: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1534: GC (Allocation Failure) [0.1534: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1553: GC (Allocation Failure) [0.1553: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1572: GC (Allocation Failure) [0.1572: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1591: GC (Allocation Failure) [0.1591: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1610: GC (Allocation Failure) [0.1610: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1629: GC (Allocation Failure) [0.1629: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1648: GC (Allocation Failure) [0.1648: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1667: GC (Allocation Failure) [0.1667: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1686: GC (Allocation Failure) [0.1686: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1705: GC (Allocation Failure) [0.1705: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1724: GC (Allocation Failure) [0.1724: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1743: GC (Allocation Failure) [0.1743: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1762: GC (Allocation Failure) [0.1762: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1781: GC (Allocation Failure) [0.1781: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1800: GC (Allocation Failure) [0.1800: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1819: GC (Allocation Failure) [0.1819: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1838: GC (Allocation Failure) [0.1838: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1857: GC (Allocation Failure) [0.1857: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1876: GC (Allocation Failure) [0.1876: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1895: GC (Allocation Failure) [0.1895: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1914: GC (Allocation Failure) [0.1914: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1933: GC (Allocation Failure) [0.1933: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1952: GC (Allocation Failure) [0.1952: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1971: GC (Allocation Failure) [0.1971: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.1990: GC (Allocation Failure) [0.1990: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2009: GC (Allocation Failure) [0.2009: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2028: GC (Allocation Failure) [0.2028: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2047: GC (Allocation Failure) [0.2047: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2066: GC (Allocation Failure) [0.2066: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2085: GC (Allocation Failure) [0.2085: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2104: GC (Allocation Failure) [0.2104: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2123: GC (Allocation Failure) [0.2123: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2142: GC (Allocation Failure) [0.2142: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2161: GC (Allocation Failure) [0.2161: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2180: GC (Allocation Failure) [0.2180: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2199: GC (Allocation Failure) [0.2199: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2218: GC (Allocation Failure) [0.2218: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2237: GC (Allocation Failure) [0.2237: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2256: GC (Allocation Failure) [0.2256: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2275: GC (Allocation Failure) [0.2275: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2294: GC (Allocation Failure) [0.2294: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2313: GC (Allocation Failure) [0.2313: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2332: GC (Allocation Failure) [0.2332: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2351: GC (Allocation Failure) [0.2351: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2370: GC (Allocation Failure) [0.2370: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2389: GC (Allocation Failure) [0.2389: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00, real=0.01 sec]
0.2408: GC (Allocation Failure) [0.2408: ParNew: 7615K->3444K(7616K)] 0.008463 sec [Times: user=0.20 sys=0.00
```

```

[Eden: 24.0M(24.0M)->0.0B(33.0M) Survivors: 3072.0K->4096.0K Heap: 40.4M(248.0M)->23.6M(248.0M)]
[Times: user=0.00 sys=0.00, real=0.02 secs]
GC pause (G1 Evacuation Pause) (young), 0.0032573 secs]
[Parallel Time: 2.4 ms, GC Workers: 13]
[GC Worker Start (ms): Min: 144.7, Avg: 144.8, Max: 144.9, Diff: 0.2]
[Ext Root Scanning (ms): Min: 0.1, Avg: 0.2, Max: 0.3, Diff: 0.2, Sum: 2.0]
[Update RS (ms): Min: 0.0, Avg: 0.1, Max: 0.3, Diff: 0.2, Sum: 1.3]
[Processed Buffers: Min: 0, Avg: 1.1, Max: 4, Diff: 4, Sum: 14]
[Scan RS (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.1]
[Code Root Scanning (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.0]
[Object Copy (ms): Min: 1.6, Avg: 1.9, Max: 2.0, Diff: 0.4, Sum: 24.3]
[Termination (ms): Min: 0.0, Avg: 0.1, Max: 0.2, Diff: 0.2, Sum: 1.2]
[Termination Attempts: Min: 1, Avg: 1.0, Max: 1, Diff: 0, Sum: 13]
[GC Worker Other (ms): Min: 0.0, Avg: 0.0, Max: 0.1, Diff: 0.1, Sum: 0.5]
[GC Worker Total (ms): Min: 2.2, Avg: 2.3, Max: 2.4, Diff: 0.2, Sum: 29.4]
[GC Worker End (ms): Min: 147.1, Avg: 147.1, Max: 147.1, Diff: 0.0]
[Code Root Fixup: 0.0 ms]
[Code Root Purge: 0.0 ms]
[Clear CT: 0.2 ms]
[Other: 0.6 ms]
[Choose CSet: 0.0 ms]
[Ref Proc: 0.1 ms]
[Ref Enq: 0.0 ms]
[Redirty Cards: 0.2 ms]
[Humongous Register: 0.0 ms]
[Humongous Reclaim: 0.0 ms]
[Free CSet: 0.0 ms]

```

G1GC 的回收效率非常快，虽然会产生 STW 但是这么快也不会受什么影响，但是对于没有对堆大小进行配置的情况下数据会比较少，只有 10000 左右，但是在堆参数很大时 G1 有明显的优势。