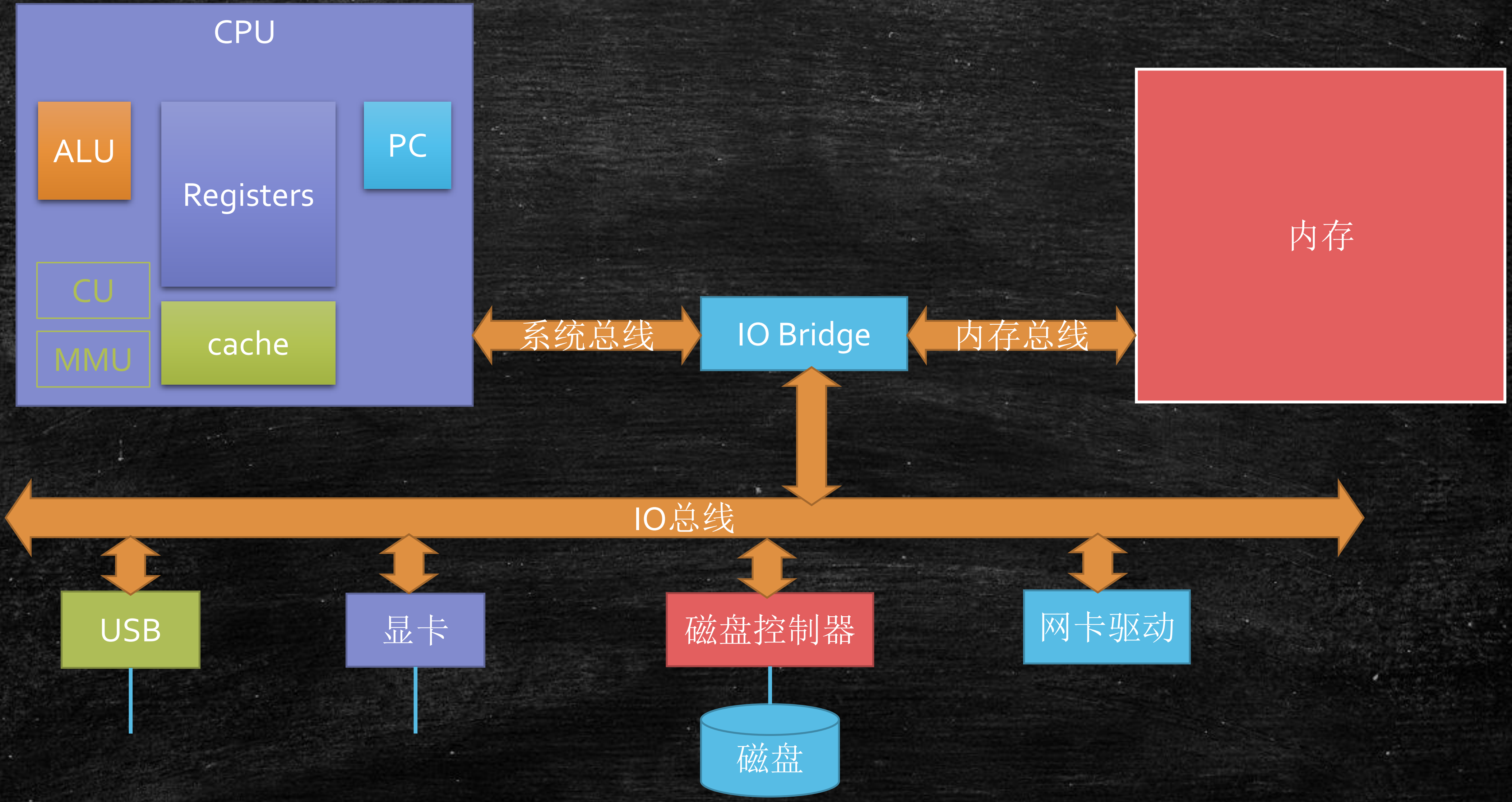
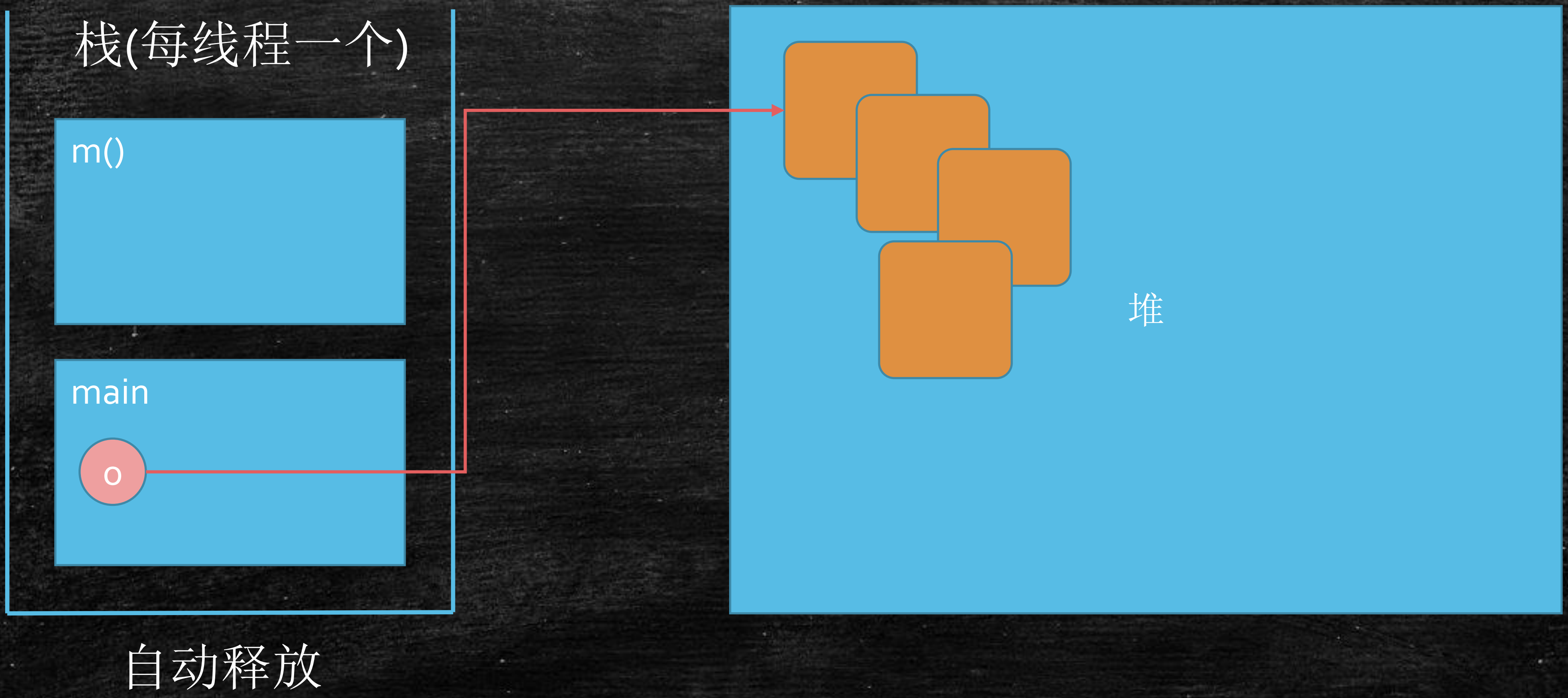
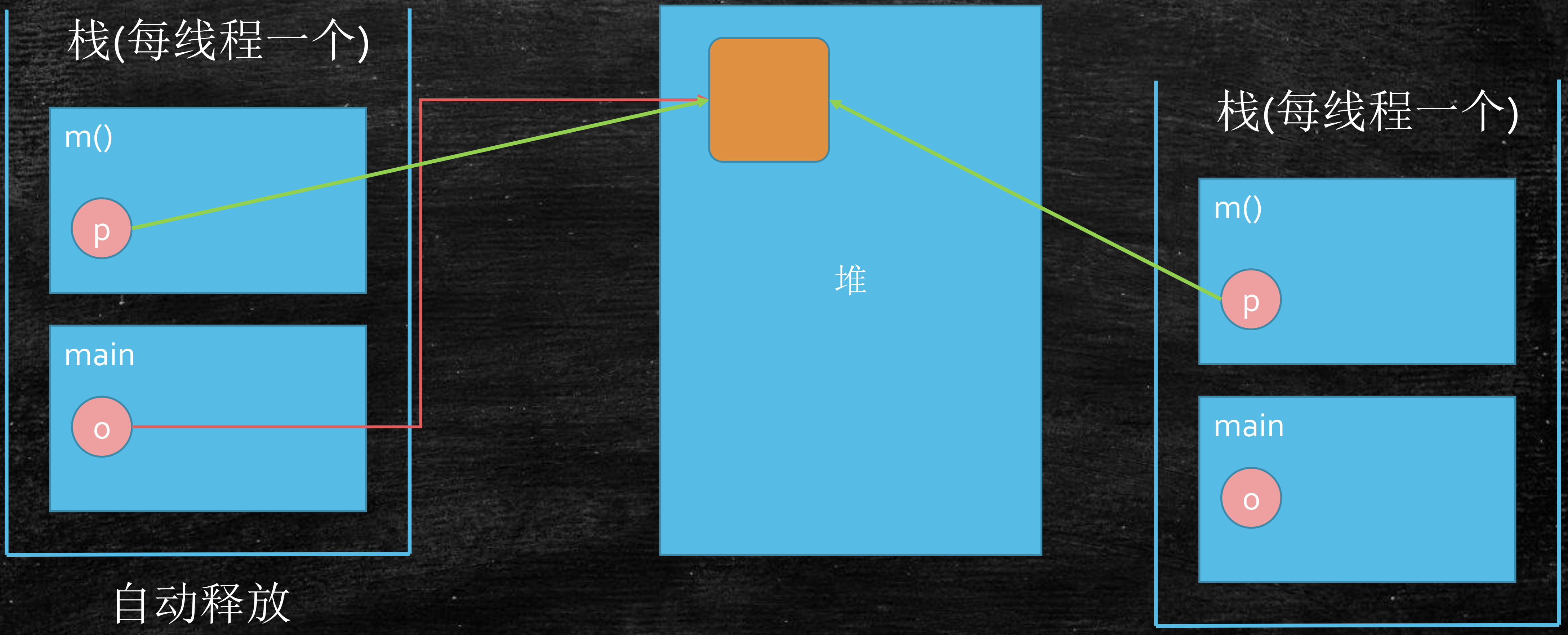
熟悉GC常用算法，熟悉常见垃圾收集器，具有实际JVM调优实战经验


CPU
ALU
Registers
PC
CU
MMU
cache
系统总线
IO Bridge
内存总线
内存
IO总线
USB
显卡
磁盘控制器
网卡驱动
磁盘

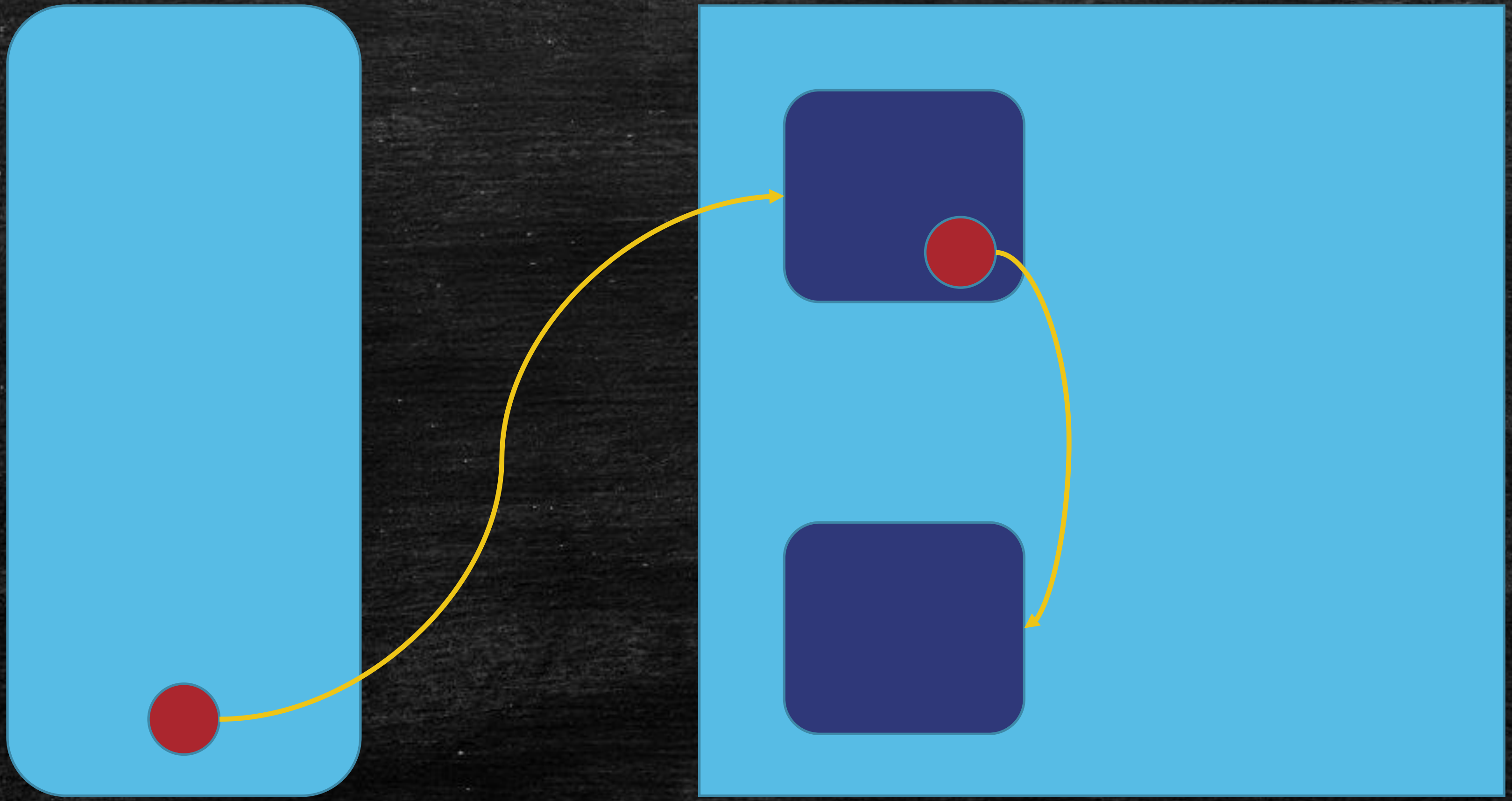
```
main {
    Object o = new Object();
    m();
}
```

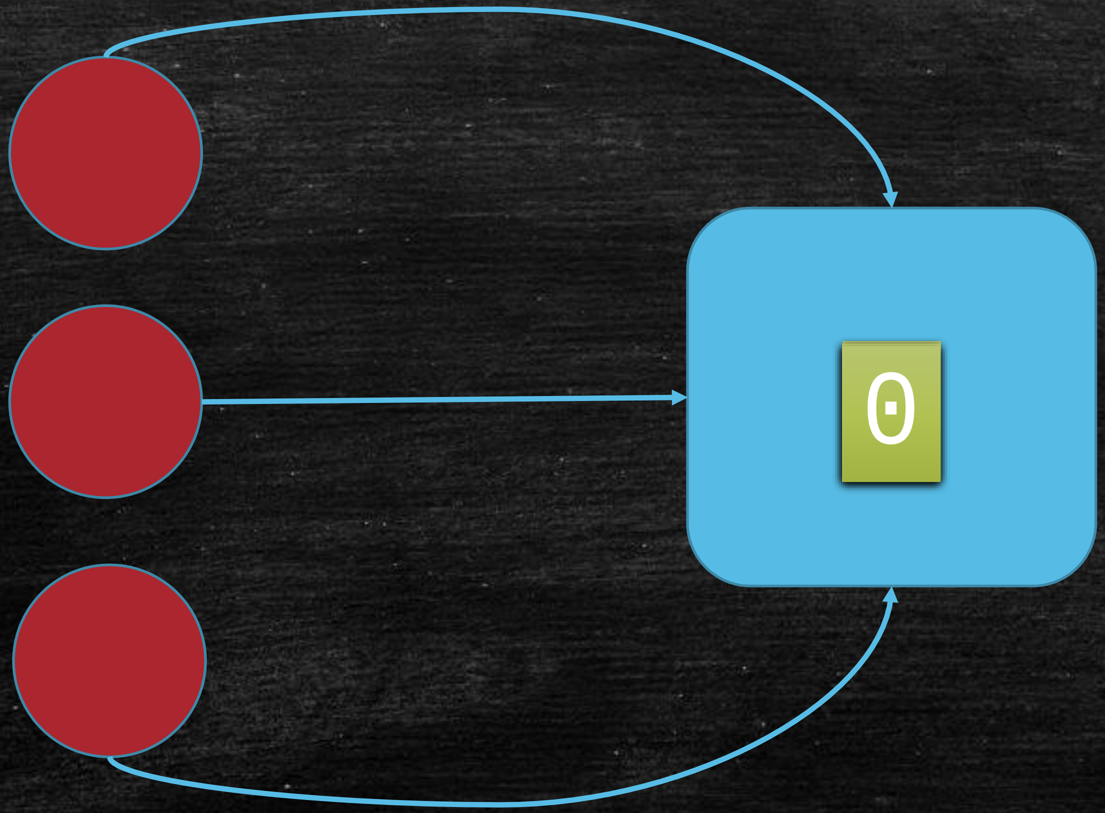


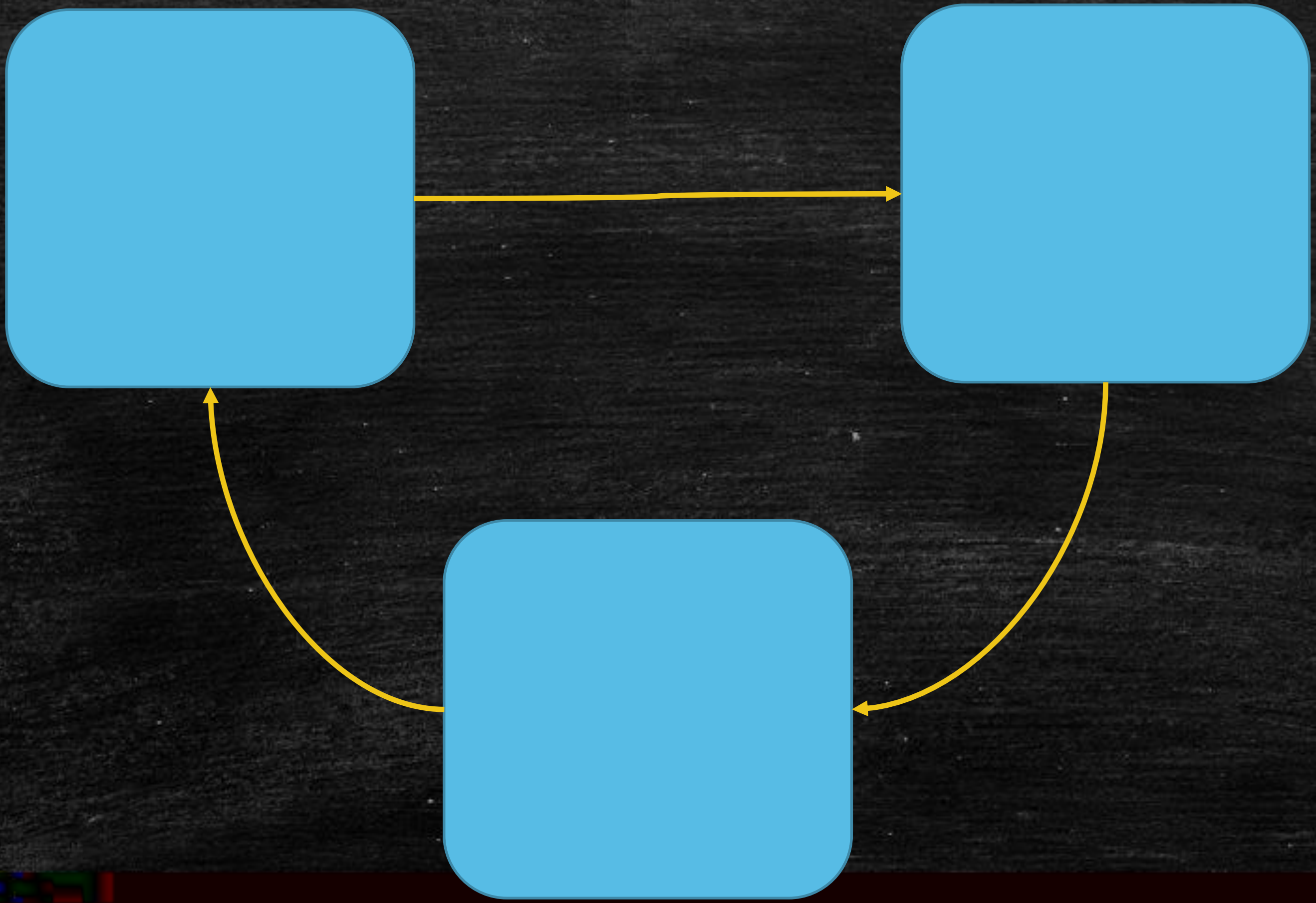
```
main {
    Object o = new Object();
    m();
}
```



自动释放




0



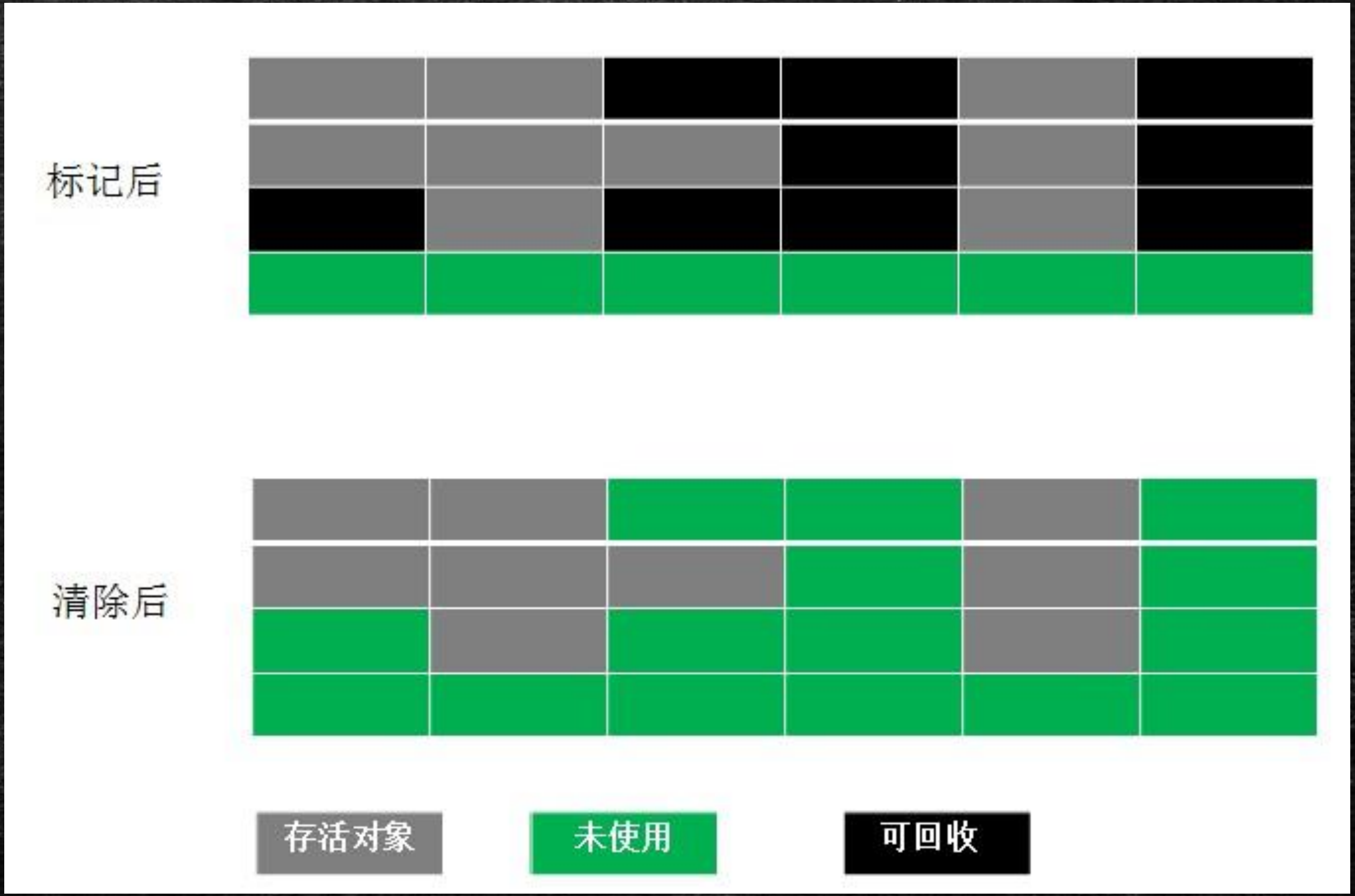
GC roots

线程

静态变量

- Mark-Sweep
- Copying
- Mark-Compact

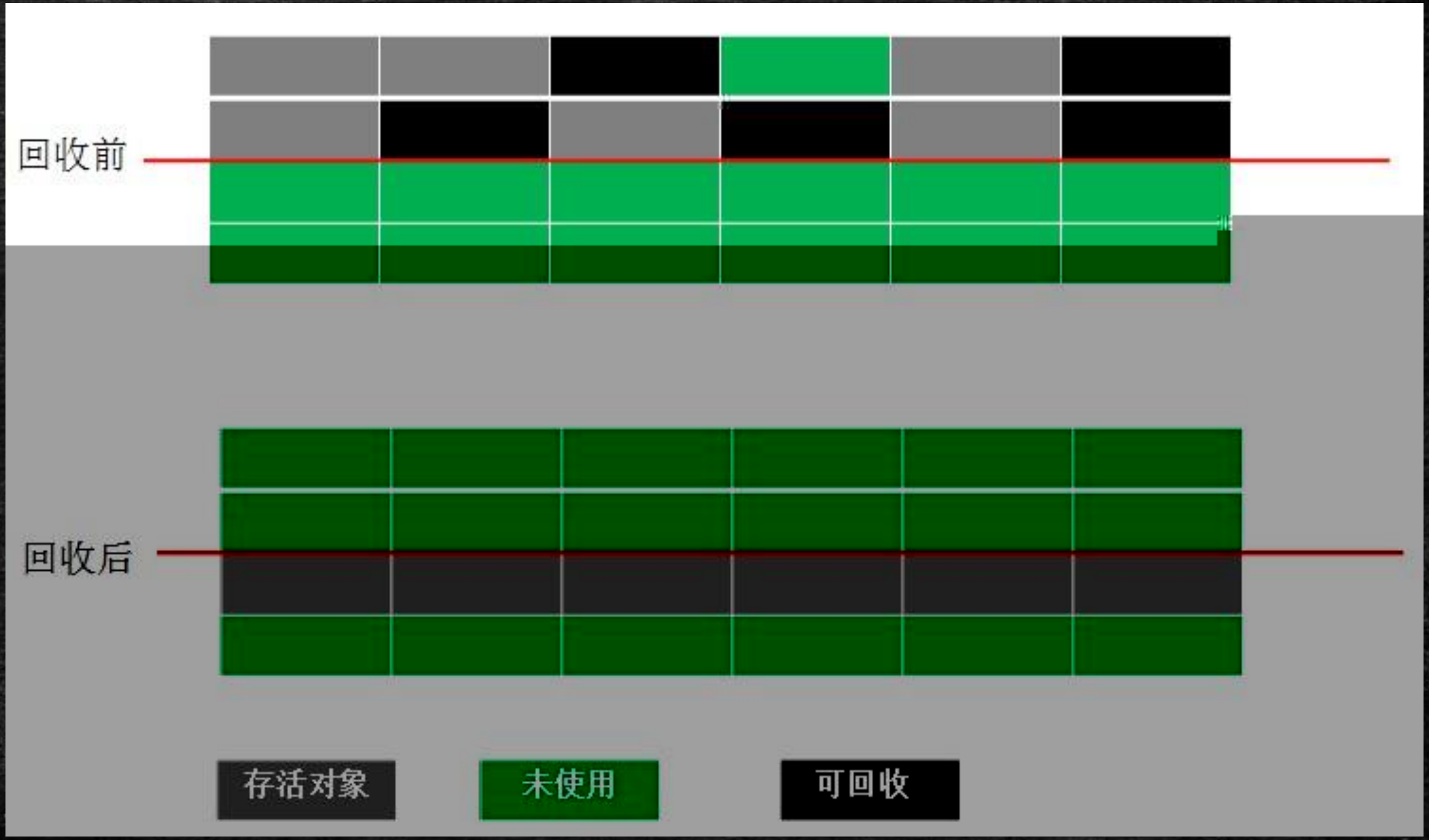
Mark-Sweep



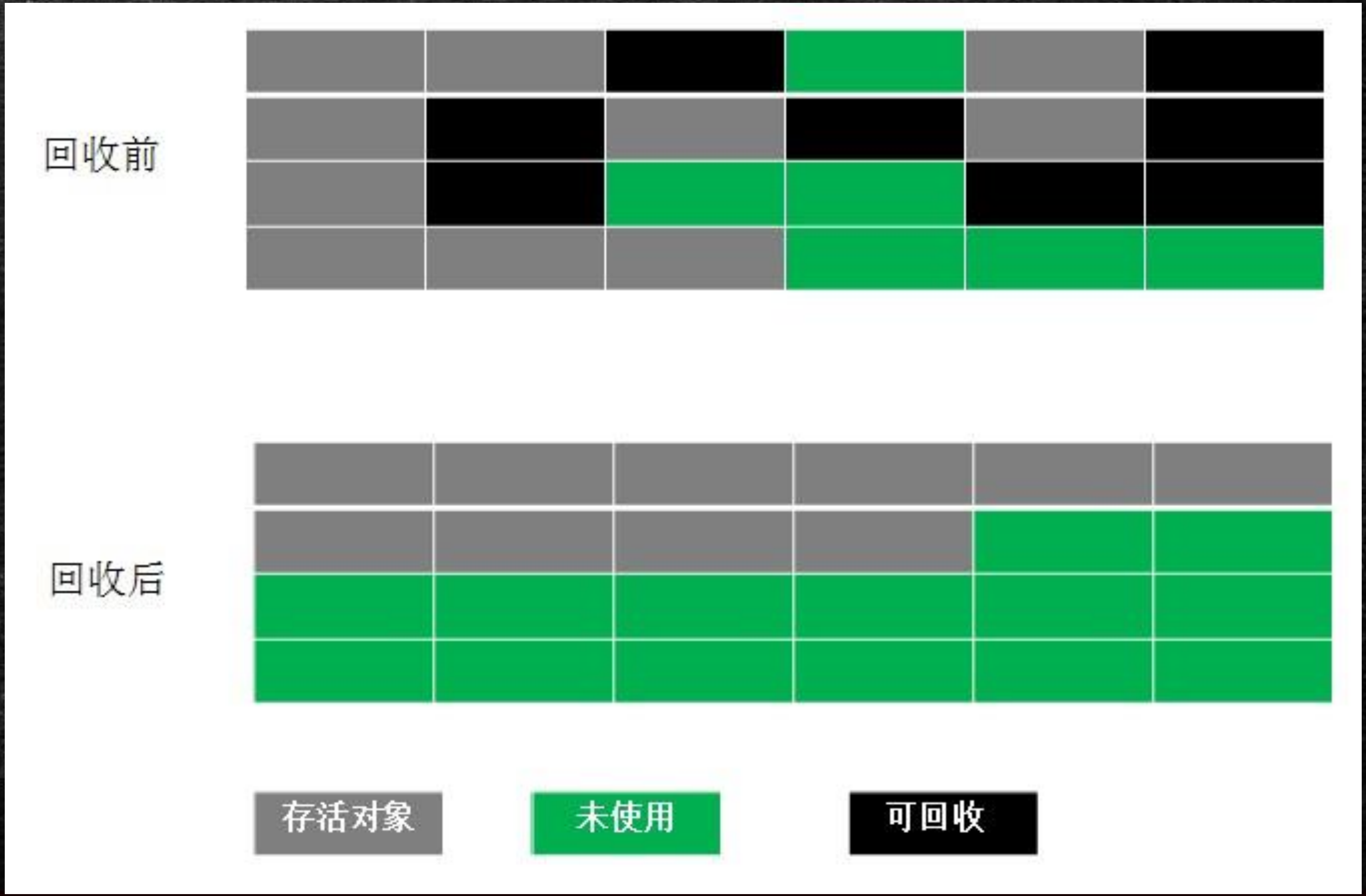
碎片化

Copying

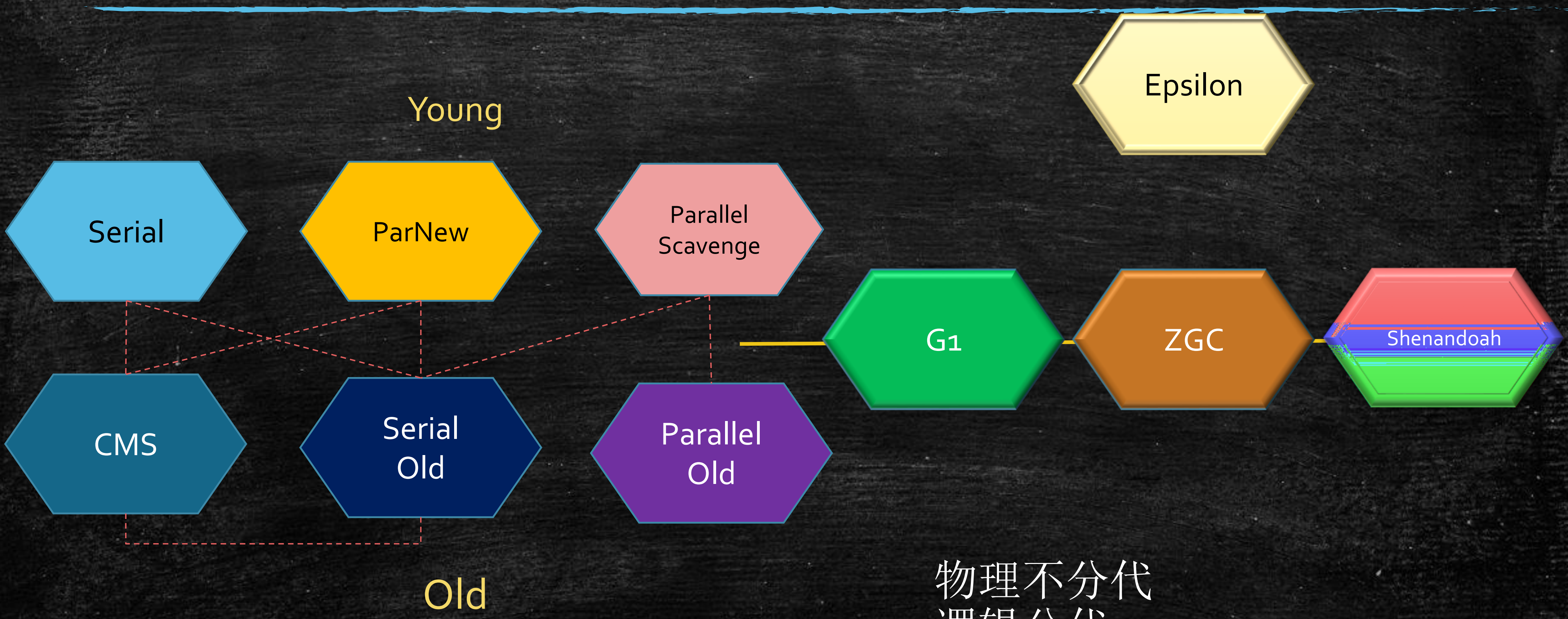
内存浪费



Mark-Compact

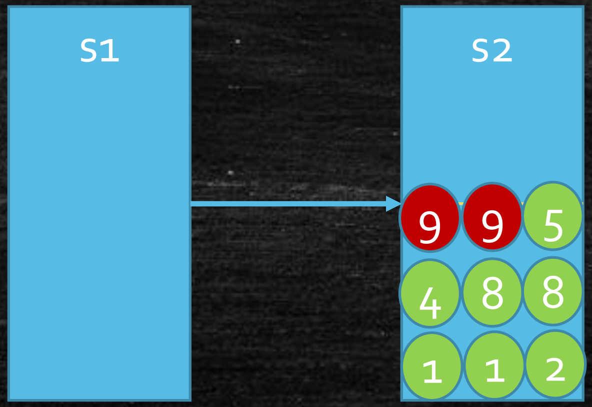


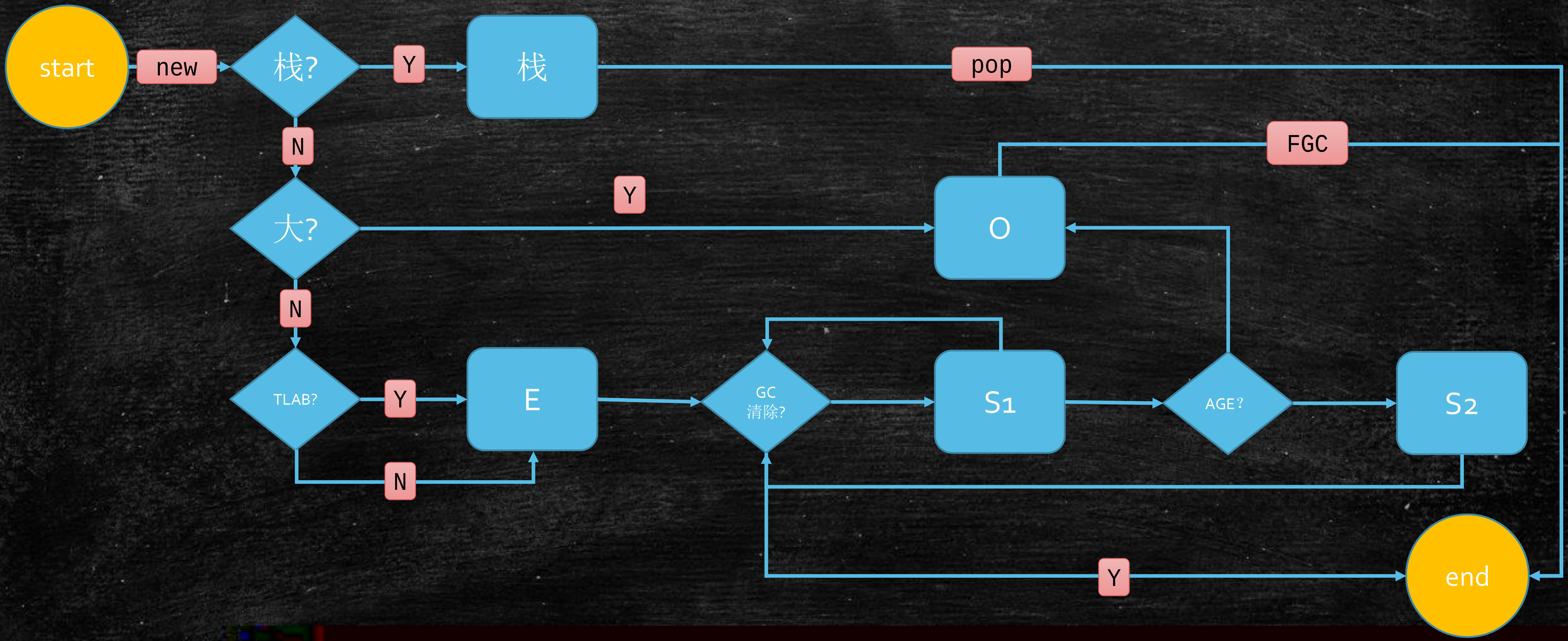
效率比copy略低



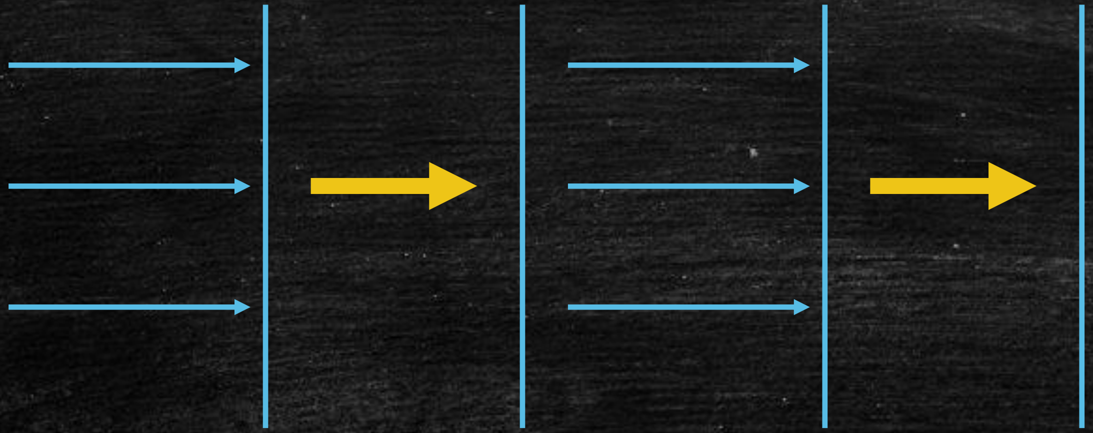
Young
Serial
ParNew
Parallel Scavenge
Epsilon
G1
ZGC
Shenandoah
CMS
Serial Old
Parallel Old
Old

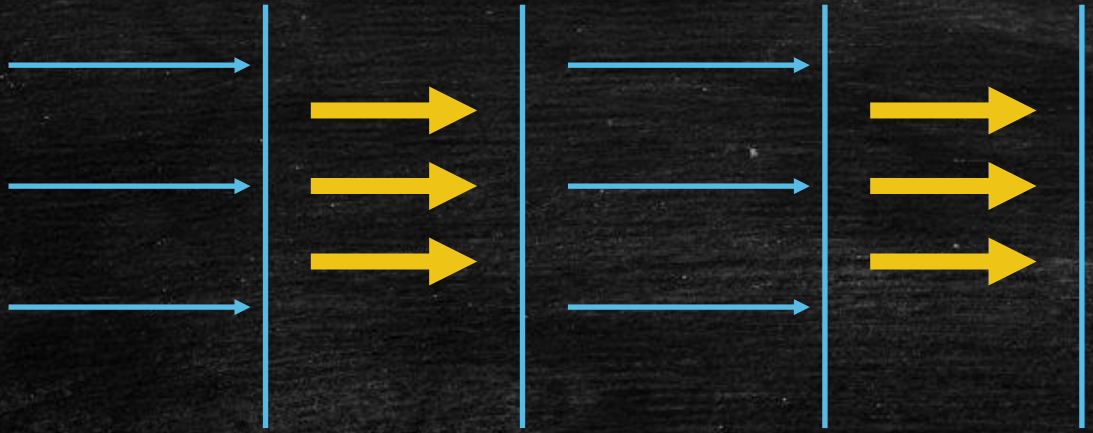
物理不分代
逻辑分代

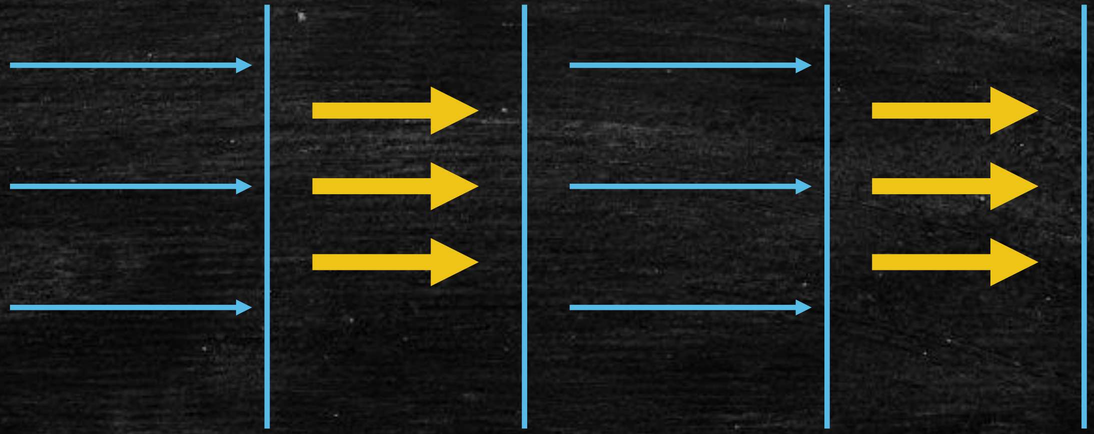

S1
S2
9
9
5
4
8
8
1
1
2


start
new
栈?
Y
栈
pop
N
FGC
Y
大?
O
N
TLAB?
Y
E
GC
清除?
S1
AGE？
S2
N
Y
end

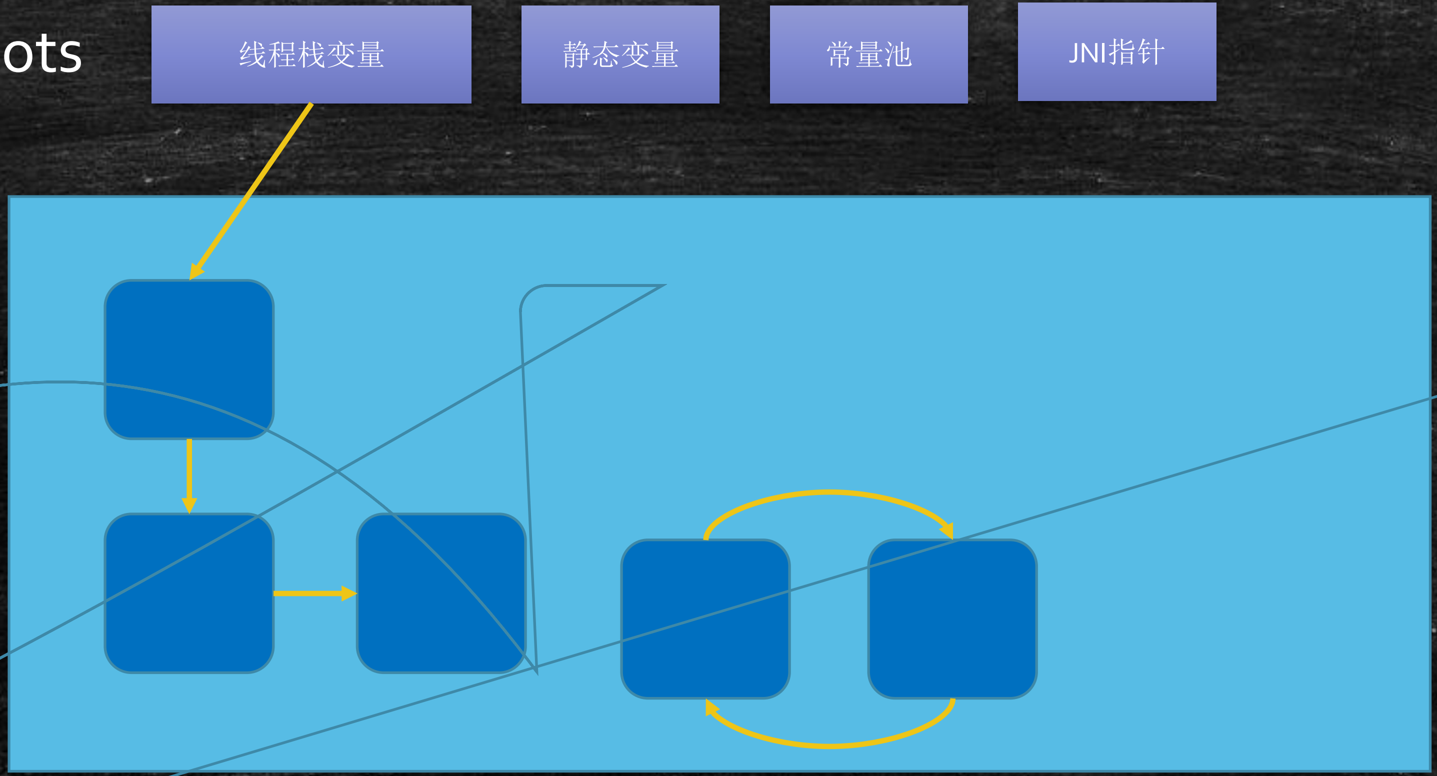
▪



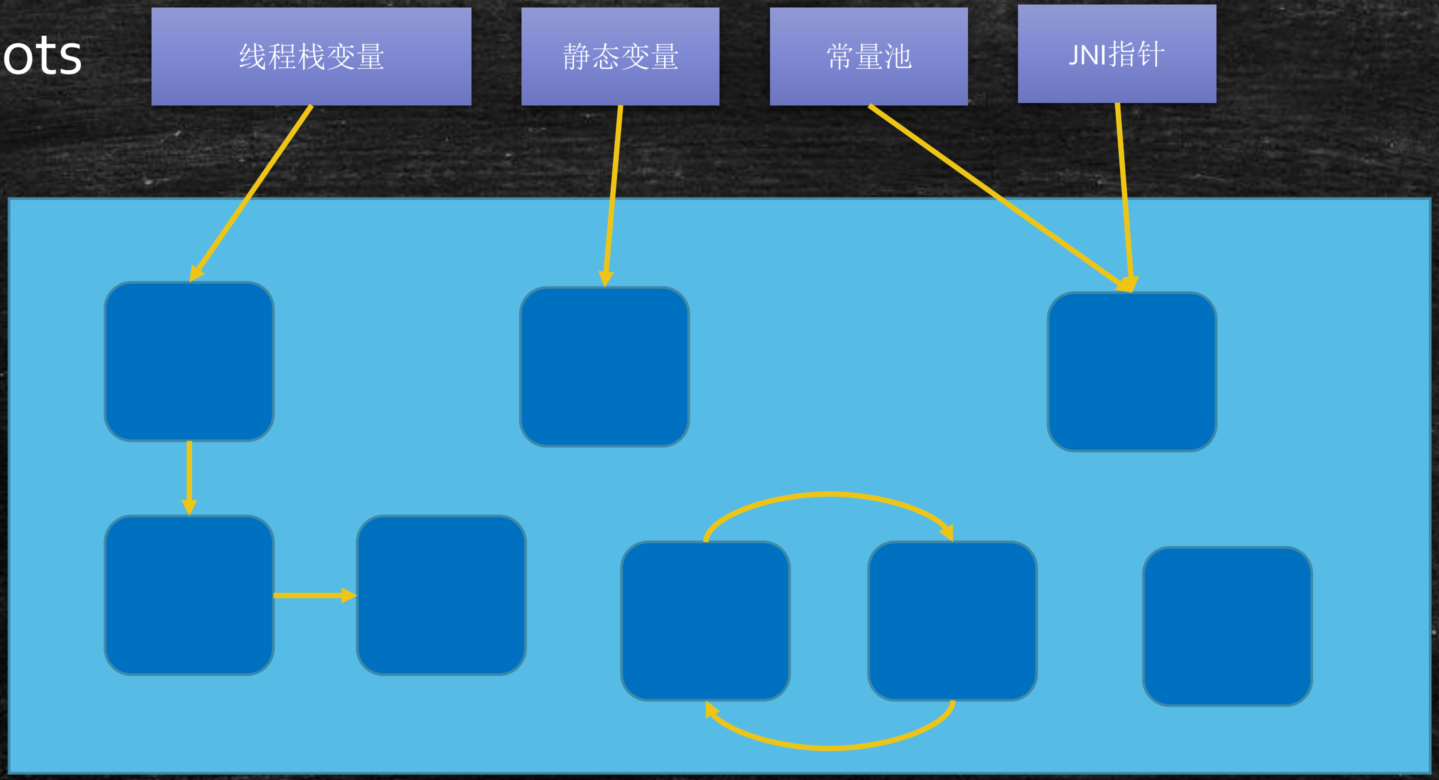




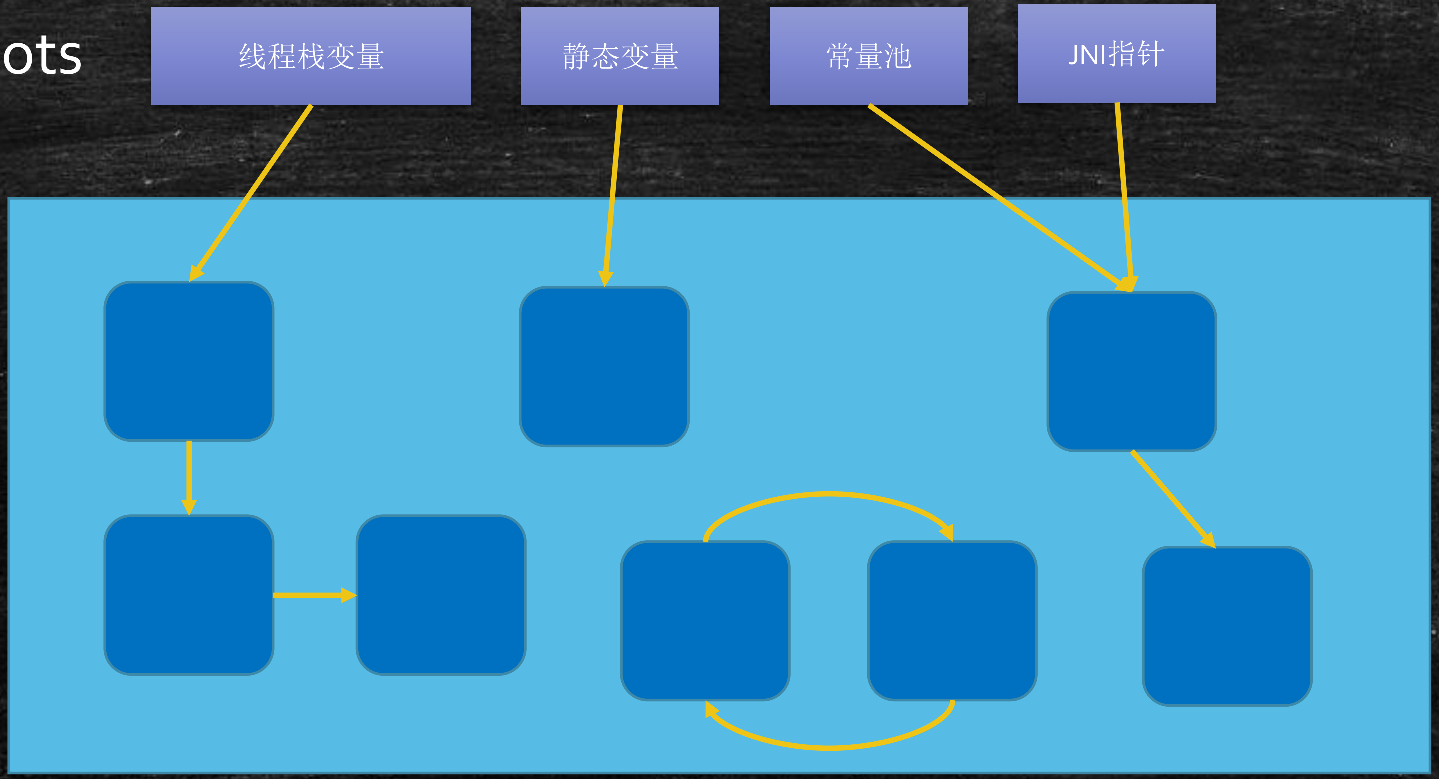
GC roots



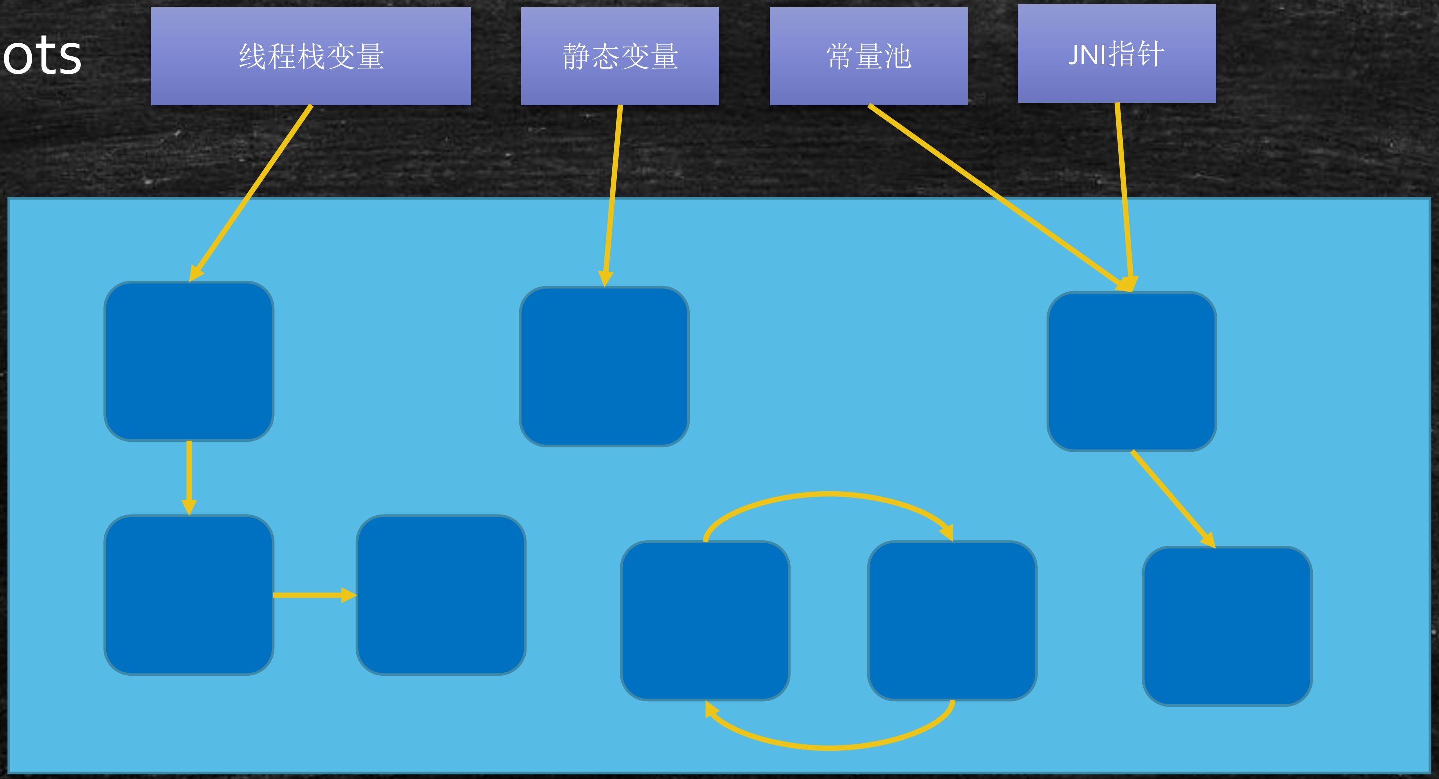
GC roots

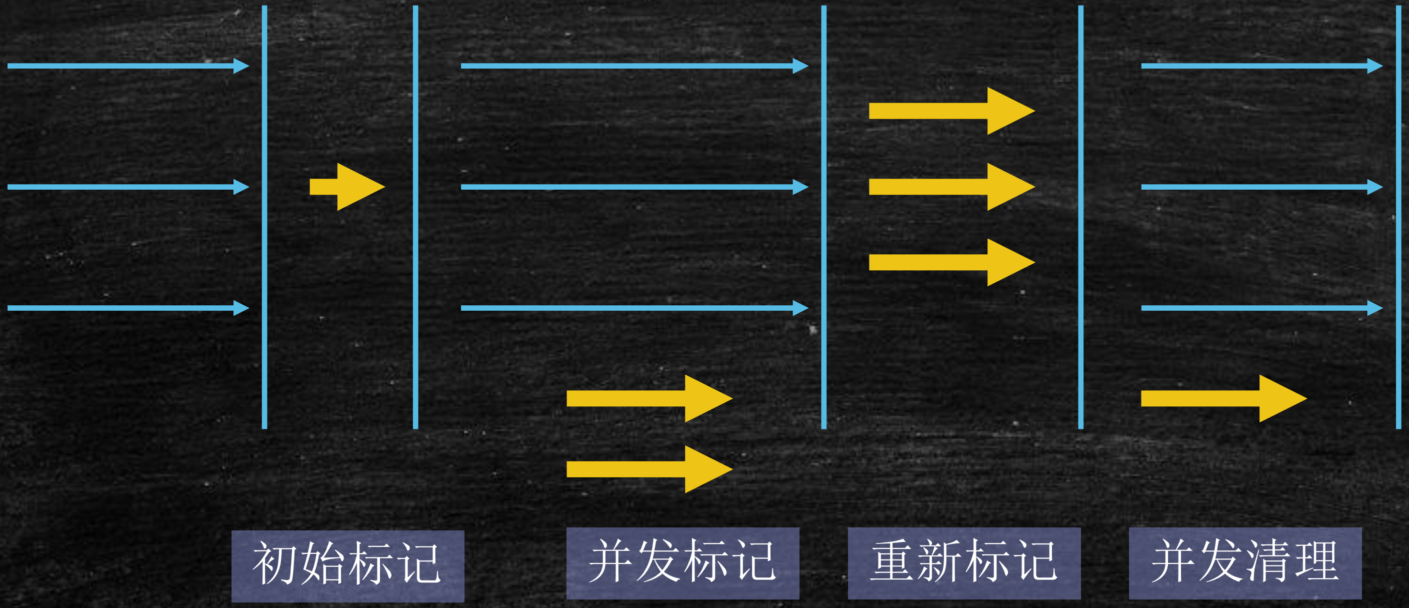


GC roots



GC roots




初始标记
并发标记
重新标记
并发清理

▪

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▪

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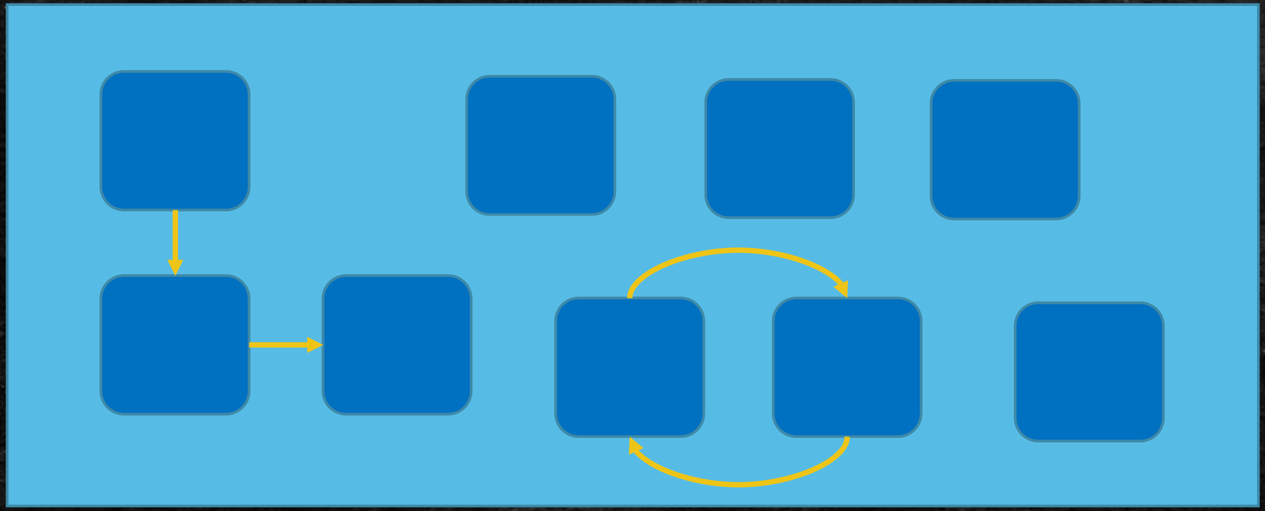
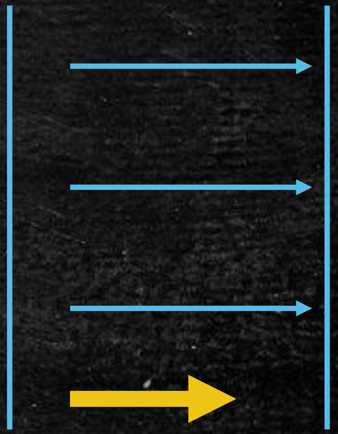


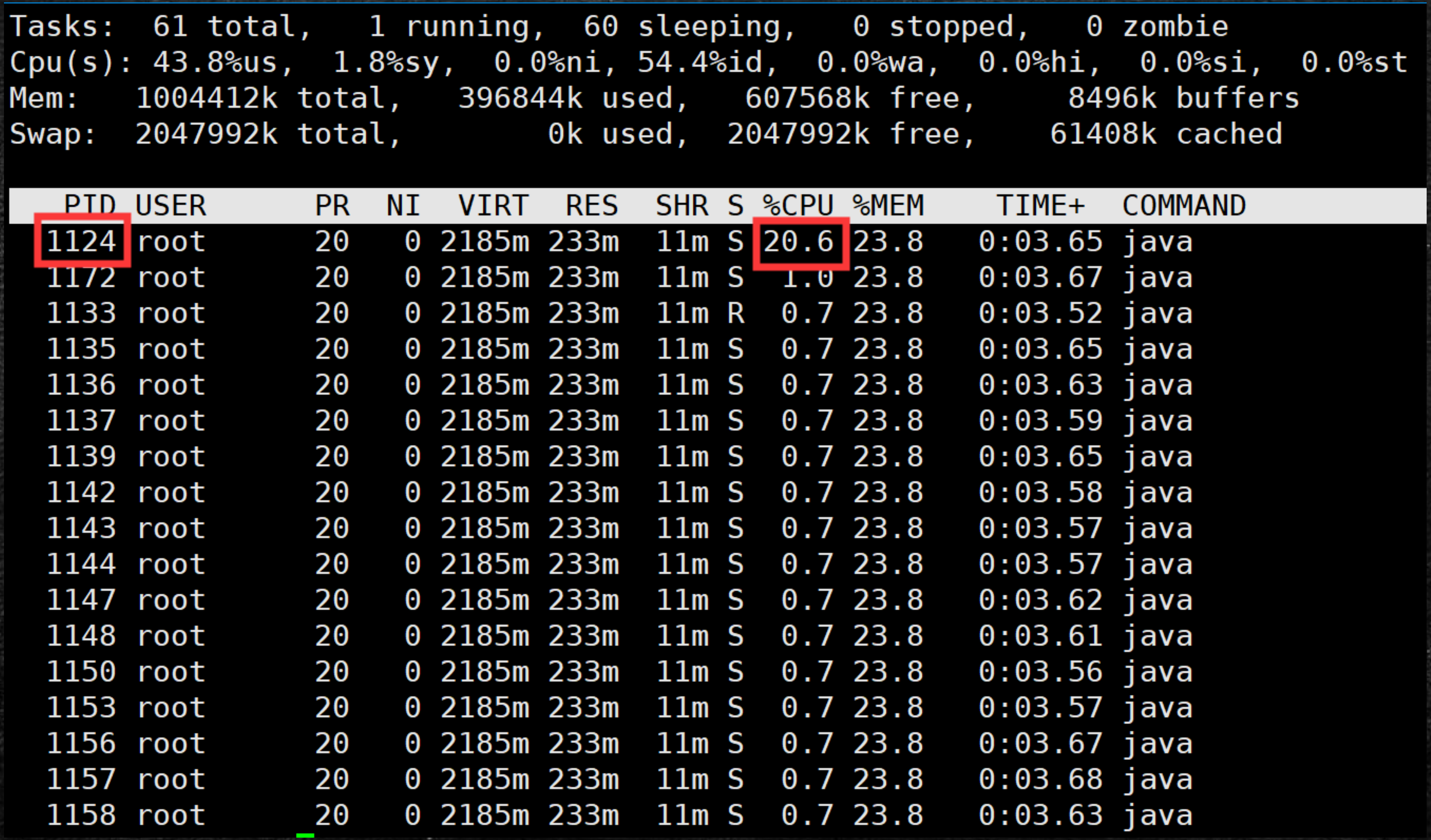


并发清理

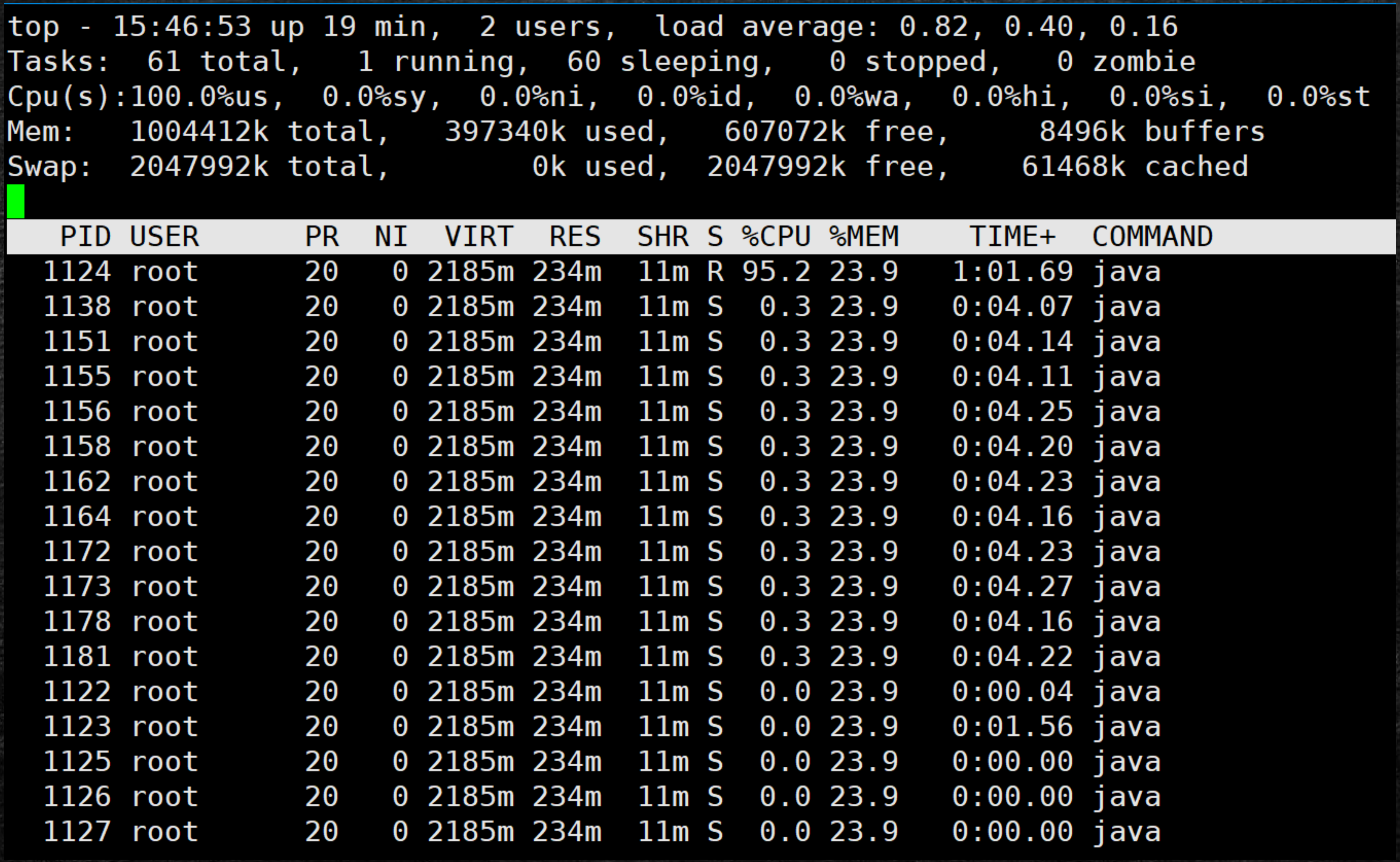
https://blogs.oracle.com/jonthecollector/our-collectors

面试：CPU突然飙高如何解决？

top –Hp 1122

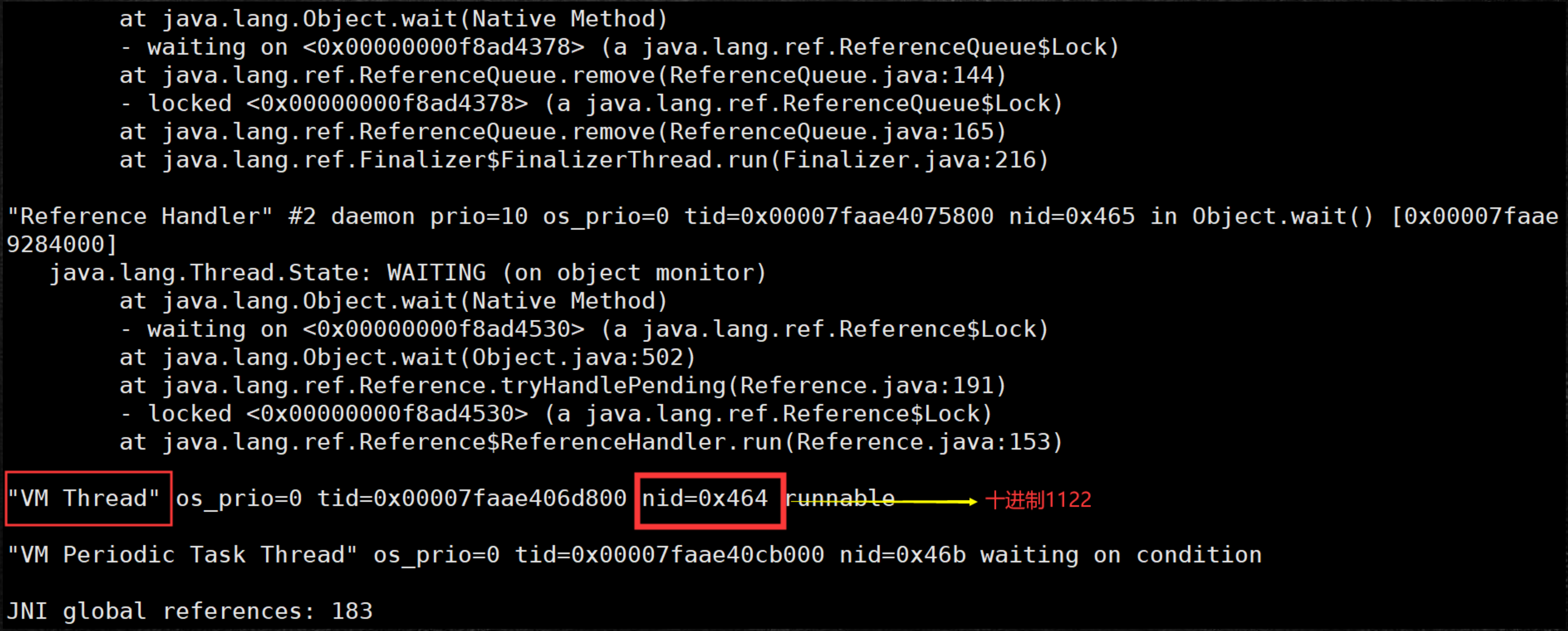


```
Tasks:  61 total,   1 running,  60 sleeping,   0 stopped,   0 zombie
Cpu(s): 43.8%us,  1.8%sy,  0.0%ni, 54.4%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Mem:   1004412k total,   396844k used,   607568k free,     8496k buffers
Swap:  2047992k total,        0k used,  2047992k free,    61408k cached

  PID USER      PR  NI  VIRT  RES  SHR S %CPU %MEM    TIME+  COMMAND
 1124 root      20   0 2185m 233m  11m S 20.6 23.8   0:03.65 java
 1172 root      20   0 2185m 233m  11m S  1.0 23.8   0:03.67 java
 1133 root      20   0 2185m 233m  11m R  0.7 23.8   0:03.52 java
 1135 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.65 java
 1136 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.63 java
 1137 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.59 java
 1139 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.65 java
 1142 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.58 java
 1143 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.57 java
 1144 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.57 java
 1147 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.62 java
 1148 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.61 java
 1150 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.56 java
 1153 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.57 java
 1156 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.67 java
 1157 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.68 java
 1158 root      20   0 2185m 233m  11m S  0.7 23.8   0:03.63 java
```



```
top - 15:46:53 up 19 min,  2 users,  load average: 0.82, 0.40, 0.16
Tasks:  61 total,   1 running,  60 sleeping,   0 stopped,   0 zombie
Cpu(s):100.0%us,  0.0%sy,  0.0%ni,  0.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Mem:   1004412k total,   397340k used,   607072k free,     8496k buffers
Swap:  2047992k total,        0k used,  2047992k free,    61468k cached

  PID USER      PR  NI  VIRT  RES  SHR S %CPU %MEM    TIME+  COMMAND
 1124 root      20   0 2185m 234m  11m R 95.2 23.9   1:01.69 java
 1138 root      20   0 2185m 234m  11m S  0.3 23.9   0:04.07 java
 1151 root      20   0 2185m 234m  11m S  0.3 23.9   0:04.14 java
 1155 root      20   0 2185m 234m  11m S  0.3 23.9   0:04.11 java
 1156 root      20   0 2185m 234m  11m S  0.3 23.9   0:04.25 java
 1158 root      20   0 2185m 234m  11m S  0.3 23.9   0:04.20 java
 1162 root      20   0 2185m 234m  11m S  0.3 23.9   0:04.23 java
 1164 root      20   0 2185m 234m  11m S  0.3 23.9   0:04.16 java
 1172 root      20   0 2185m 234m  11m S  0.3 23.9   0:04.23 java
 1173 root      20   0 2185m 234m  11m S  0.3 23.9   0:04.27 java
 1178 root      20   0 2185m 234m  11m S  0.3 23.9   0:04.16 java
 1181 root      20   0 2185m 234m  11m S  0.3 23.9   0:04.22 java
 1122 root      20   0 2185m 234m  11m S  0.0 23.9   0:00.04 java
 1123 root      20   0 2185m 234m  11m S  0.0 23.9   0:01.56 java
 1125 root      20   0 2185m 234m  11m S  0.0 23.9   0:00.00 java
 1126 root      20   0 2185m 234m  11m S  0.0 23.9   0:00.00 java
 1127 root      20   0 2185m 234m  11m S  0.0 23.9   0:00.00 java
```

jstack 1122

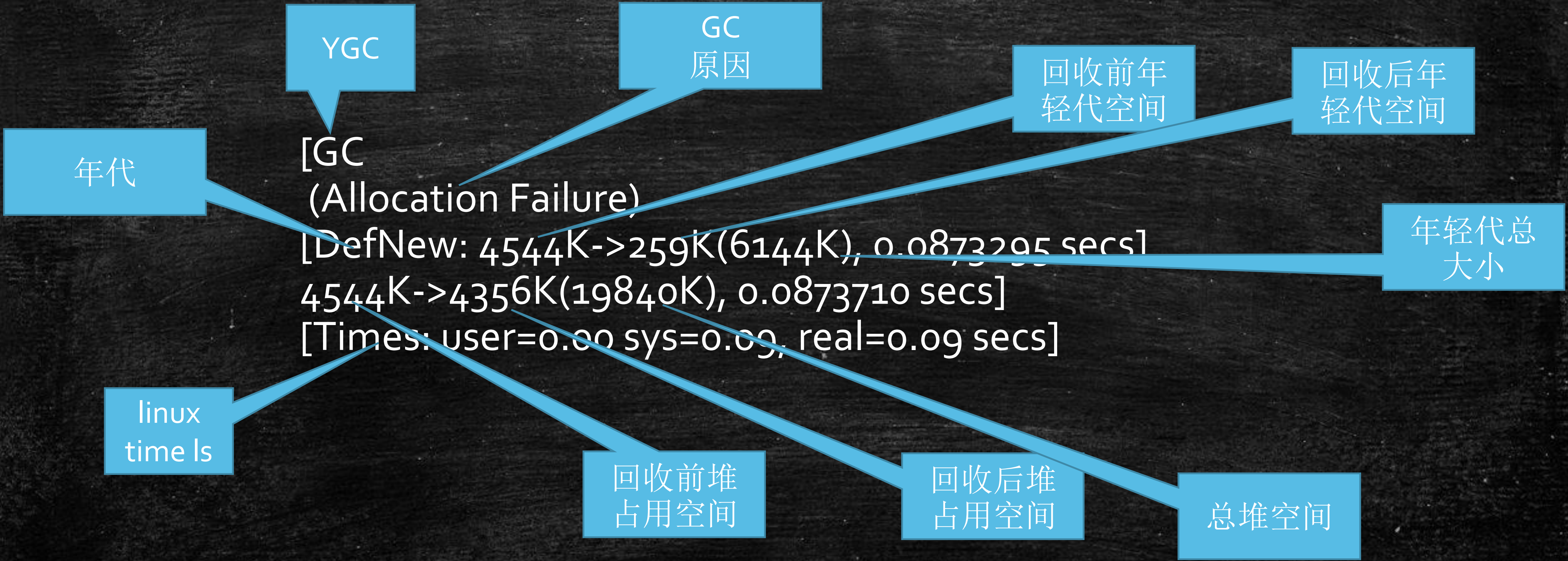


```
        at java.lang.Object.wait(Native Method)
        - waiting on <0x00000000f8ad4378> (a java.lang.ref.ReferenceQueue$Lock)
        at java.lang.ref.ReferenceQueue.remove(ReferenceQueue.java:144)
        - locked <0x00000000f8ad4378> (a java.lang.ref.ReferenceQueue$Lock)
        at java.lang.ref.ReferenceQueue.remove(ReferenceQueue.java:165)
        at java.lang.ref.Finalizer$FinalizerThread.run(Finalizer.java:216)

"Reference Handler" #2 daemon prio=10 os_prio=0 tid=0x00007faae4075800 nid=0x465 in Object.wait() [0x00007faae
9284000]
   java.lang.Thread.State: WAITING (on object monitor)
        at java.lang.Object.wait(Native Method)
        - waiting on <0x00000000f8ad4530> (a java.lang.ref.Reference$Lock)
        at java.lang.Object.wait(Object.java:502)
        at java.lang.ref.Reference.tryHandlePending(Reference.java:191)
        - locked <0x00000000f8ad4530> (a java.lang.ref.Reference$Lock)
        at java.lang.ref.Reference$ReferenceHandler.run(Reference.java:153)

"VM Thread" os_prio=0 tid=0x00007faae406d800 nid=0x464 runnable

"VM Periodic Task Thread" os_prio=0 tid=0x00007faae40cb000 nid=0x46b waiting on condition

JNI global references: 183
```

吞吐量 = 用户代码执行时间 / (用户代码执行时间 + 垃圾收集执行时间)
响应时间快 = 用户线程停顿的时间短

确定调优之前，应该确定到底是哪个优先，是计算型任务还是响应型任务

GC日志详解



```
[GC
 (Allocation Failure)
[DefNew: 4544K->259K(6144K), 0.0873295 secs]
4544K->4356K(19840K), 0.0873710 secs]
[Times: user=0.00 sys=0.09, real=0.09 secs]
```

```
Heap
 def new generation   total 6144K, used 5504K [0x00000000fec00000, 0x00000000ff2a0000,
0x00000000ff2a0000)
  eden space 5504K, 100% used [0x00000000fec00000, 0x00000000ff160000, 0x00000000ff160000)
  from space 640K,   0% used [0x00000000ff160000, 0x00000000ff160000, 0x00000000ff200000)
  to   space 640K,   0% used [0x00000000ff200000, 0x00000000ff200000, 0x00000000ff2a0000)
 tenured generation   total 13696K, used 13312K [0x00000000ff2a0000, 0x0000000100000000,
0x0000000100000000)
   the space 13696K,  97% used [0x00000000ff2a0000, 0x00000000fffa0148, 0x00000000fffa0200,
0x0000000100000000
) Metaspace       used 2538K, capacity 4486K, committed 4864K, reserved 1056768K
  class space    used 275K, capacity 386K, committed 512K, reserved 1048576K
```

已经使用

总容量

虚拟内存
占用

虚拟内存
保留

案例
有一个50万PV的资料类网站（从磁盘提取文档到内存）原服务器32位，1.5G的堆，用户反馈网站比较缓慢，因此公司决定升级，新的服务器为64位，16G的堆内存，结果用户反馈卡顿十分严重，反而比以前效率更低了

为什么？
如何优化？

案例：
开源软件Xfire缺陷
https://blog.csdn.net/qq_15037231/article/details/80689905