● 使用 G1 GC 启动一个程序，仿照课上案例分析一下 JVM 情况
【选做】

使用 jmap，jstat，jstack，以及可视化工具，查看 jvm 情况。 mac 上可以用 wrk ， windows 上 可 以 按 照 superbenchmark 压 测 http://localhost:8088/api/hello 查看 jvm。

```
/Library/Java/JavaVirtualMachines/jdk1.8.0-91.jdk/Content
s/Hom/bin/java  -Xmx1g  -Xms1g  -XX:-UseAdaptiveSizePolicy
-XX:+UseG1GC -jar target/robin-0.0.1-SNAPSHOT.jar
```

(1)jmap -heap <PID>
```
Attaching to process ID 12497, please wait...
Debugger attached successfully.
Server compiler detected.
JVM version is 25.91-b14

using thread-local object allocation.
Garbage-First (G1) GC with 4 thread(s)

Heap Configuration:
   MinHeapFreeRatio         = 40
   MaxHeapFreeRatio         = 70
   MaxHeapSize              = 1073741824 (1024.0MB)
   NewSize                  = 1363144 (1.2999954223632812MB)
   MaxNewSize               = 643825664 (614.0MB)
   OldSize                  = 5452592 (5.1999969482421875MB)
   NewRatio                 = 2
   SurvivorRatio            = 8
   MetaspaceSize            = 21807104 (20.796875MB)
   CompressedClassSpaceSize = 1073741824 (1024.0MB)
   MaxMetaspaceSize         = 17592186044415 MB
   G1HeapRegionSize         = 1048576 (1.0MB)

Heap Usage:
G1 Heap:
   regions  = 1024
   capacity = 1073741824 (1024.0MB)
   used     = 239374832 (228.28562927246094MB)
   free     = 834366992 (795.7143707275391MB)
   22.293518483638763% used
G1 Young Generation:
Eden Space:
   regions  = 124
```

```
    capacity = 665845760 (635.0MB)
    used     = 130023424 (124.0MB)
    free     = 535822336 (511.0MB)
    19.52755905511811% used
Survivor Space:
    regions = 10
    capacity = 10485760 (10.0MB)
    used     = 10485760 (10.0MB)
    free     = 0 (0.0MB)
    100.0% used
G1 Old Generation:
    regions = 95
    capacity = 397410304 (379.0MB)
    used     = 98865648 (94.28562927246094MB)
    free     = 298544656 (284.71437072753906MB)
    24.877474742074124% used
```

(2)jstat

jstat -gcutil 12497 1000 1000

S0	S1	E	O	M	CCS	YGC	YGCT	FGC	FGCT	GCT
0.00	100.00	80.70	24.75	95.36	93.58	24	1.006	0	0.000	1.006
0.00	100.00	43.13	24.88	95.07	93.62	25	1.046	0	0.000	1.046
0.00	100.00	12.95	24.75	95.40	93.63	26	1.068	0	0.000	1.068
0.00	100.00	78.36	24.75	95.40	93.63	26	1.068	0	0.000	1.068
0.00	100.00	53.08	24.75	95.16	93.63	27	1.089	0	0.000	1.089
0.00	100.00	23.06	24.88	95.25	93.63	28	1.110	0	0.000	1.110
0.00	100.00	3.00	24.75	95.29	93.63	29	1.131	0	0.000	1.131
0.00	100.00	71.25	24.75	95.29	93.63	29	1.131	0	0.000	1.131
0.00	100.00	45.02	24.75	95.32	93.63	30	1.157	0	0.000	1.157
0.00	100.00	9.16	24.75	95.34	93.63	31	1.203	0	0.000	1.203
0.00	100.00	95.10	24.75	95.34	93.63	32	1.203	0	0.000	1.203
0.00	100.00	88.94	24.88	95.34	93.63	32	1.236	0	0.000	1.236
0.00	100.00	95.10	24.75	95.34	93.63	34	1.254	0	0.000	1.254
0.00	100.00	76.06	25.24	95.34	93.63	34	1.275	0	0.000	1.275
0.00	100.00	58.58	25.52	95.34	93.63	35	1.303	0	0.000	1.303
0.00	100.00	35.64	26.24	95.34	93.63	36	1.328	0	0.000	1.328
0.00	100.00	20.38	26.78	95.36	93.64	37	1.346	0	0.000	1.346
0.00	100.00	4.98	28.61	95.36	93.64	38	1.369	0	0.000	1.369
0.00	100.00	9.80	29.09	95.36	93.64	39	1.380	0	0.000	1.380

 (3)jstack

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Full thread dump Java HotSpot(TM) 64-Bit Server VM (25.91-b14 mixed mode):

"Attach   Listener"   #41   daemon   prio=9   os_prio=31 tid=0x00007fa271c1d800   nid=0x4907   waiting   on   condition [0x0000000000000000]

*   java.lang.Thread.State: RUNNABLE*

"http-nio-8080-exec-11"   #40   daemon   prio=5   os_prio=31

```
tid=0x00007fa272b86000 nid=0x8d03 waiting on condition
[0x000070000d90b000]
   java.lang.Thread.State: TIMED_WAITING (parking)
   at sun.misc.Unsafe.park(Native Method)
   - parking to wait for  <0x0000000781871d28>  (a
java.util.concurrent.locks.AbstractQueuedSynchronizer$Con
ditionObject)
   at
java.util.concurrent.locks.LockSupport.parkNanos(LockSupp
ort.java:215)
   at
java.util.concurrent.locks.AbstractQueuedSynchronizer$Con
ditionObject.awaitNanos(AbstractQueuedSynchronizer.java:2
078)
   at
java.util.concurrent.LinkedBlockingQueue.poll(LinkedBlock
ingQueue.java:467)
   at
org.apache.tomcat.util.threads.TaskQueue.poll(TaskQueue.j
ava:85)
   at
org.apache.tomcat.util.threads.TaskQueue.poll(TaskQueue.j
ava:31)
   at
java.util.concurrent.ThreadPoolExecutor.getTask(ThreadPoo
lExecutor.java:1066)
   at
java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadP
oolExecutor.java:1127)
   at
java.util.concurrent.ThreadPoolExecutor$Worker.run(Thread
PoolExecutor.java:617)
   at
org.apache.tomcat.util.threads.TaskThread$WrappingRunnabl
e.run(TaskThread.java:61)
   at java.lang.Thread.run(Thread.java:745)

"DestroyJavaVM" #39 prio=5 os_prio=31 tid=0x00007fa2719d3800
nid=0x2503 waiting on condition [0x0000000000000000]
   java.lang.Thread.State: RUNNABLE

"http-nio-8080-AsyncTimeout" #37 daemon prio=5 os_prio=31
tid=0x00007fa2732f3000 nid=0x6d03 waiting on condition
[0x000070000d808000]
```

```
java.lang.Thread.State: TIMED_WAITING (sleeping)
at java.lang.Thread.sleep(Native Method)
at
org.apache.coyote.AbstractProtocol$AsyncTimeout.run(Abstr
actProtocol.java:1133)
at java.lang.Thread.run(Thread.java:745)


"http-nio-8080-Acceptor-0" #36 daemon prio=5 os_prio=31
tid=0x00007fa26dfbe800        nid=0x9003        runnable
[0x000070000d705000]
java.lang.Thread.State: RUNNABLE
at    sun.nio.ch.ServerSocketChannelImpl.accept0(Native
Method)
at
sun.nio.ch.ServerSocketChannelImpl.accept(ServerSocketCha
nnelImpl.java:422)
at
sun.nio.ch.ServerSocketChannelImpl.accept(ServerSocketCha
nnelImpl.java:250)
- locked <0x0000000781871700> (a java.lang.Object)
at
org.apache.tomcat.util.net.NioEndpoint$Acceptor.run(NioEn
dpoint.java:455)
at java.lang.Thread.run(Thread.java:745)


...
```

(4)jvisualVM

Java VisualVM

Applications | Start Page | robin-0.0.1-SNAPSHOT.jar (pid 12497)

- Local
  - Idea (pid 37145)
  - Tomcat (pid 41490)
  - VisualVM
  - robin-0.0.1-SNAPSHOT.jar (pid 124
- Remote
- VM Coredumps
- Snapshots

Overview | Monitor | Threads | Sampler | Profiler

robin-0.0.1-SNAPSHOT.jar (pid 12497)

Overview — ☑ Saved data ☑ Details

PID: 12497
Host: localhost
Main class: robin-0.0.1-SNAPSHOT.jar
Arguments: <none>

JVM: Java HotSpot(TM) 64-Bit Server VM (25.91-b14, mixed mode)
Java: version 1.8.0_91, vendor Oracle Corporation
Java Home: /Library/Java/JavaVirtualMachines/jdk1.8.0-91.jdk/Contents/Hom/jre
JVM Flags: <none>

Heap dump on OOME: disabled

Saved data | JVM arguments | System properties

Thread Dumps: 0   -Xmx1g
Heap Dumps: 0   -Xms1g
Profiler Snapshots: 0   -XX:-UseAdaptiveSizePolicy
                -XX:+UseG1GC

Start Page | robin-0.0.1-SNAPSHOT.jar (pid 12497)

Overview | Monitor | Threads | Sampler | Profiler

robin-0.0.1-SNAPSHOT.jar (pid 12497)

Monitor   ☑ CPU   ☑ Memory   ☑ Classes   ☑ Threads

Uptime: 18 min 37 sec   Perform GC   Heap Dump

CPU

- CPU usage ■ GC activity

Heap | Metaspace

- Heap size ■ Used heap

Classes

- Total loaded classes ■ Shared loaded classes

Threads

- Live threads ■ Daemon threads