

操作系统第 9 章作业

1. 计算 3 个工作在随机种子为 1、2 和 3 时的模拟解。

随机种子为 1:

```
调度_比例份额$ python2 lottery.py -j 3 -s 1
ARG jlist
ARG jobs 3
ARG maxlen 10
ARG maxticket 100
ARG quantum 1
ARG seed 1

Here is the job list, with the run time of each job:
  Job 0 ( length = 1, tickets = 84 )
  Job 1 ( length = 7, tickets = 25 )
  Job 2 ( length = 4, tickets = 44 )

Here is the set of random numbers you will need (at most):
Random 651593
Random 788724
Random 93859
Random 28347
Random 835765
Random 432767
Random 762280
Random 2106
Random 445387
Random 721540
Random 228762
Random 945271
```

作业 0 (length=1, 彩票编号:0-83)

作业 1 (length=7, 彩票编号:84-108)

作业 2 (length=4, 彩票编号:109-152)

时间片为 1

$651593 \% 153 = 119$, 获奖彩票编号为 119, 所以运行作业 2

$788724 \% 153 = 9$, 获奖彩票编号为 9, 所以运行作业 0,

至此作业 0 完成, **更新彩票总数与彩票编号**

作业 1 (length=7, 彩票编号:0-24)

作业 2 (length=4, 彩票编号:25-68)

$93859 \% 69 = 19$, 获奖彩票编号为 19, 所以运行作业 1

以此类推……

得出下表:

时间线		job0	job1	job2
0	剩余时间	1	7	4
0	运行作业			*
1	剩余时间	1	7	3
1	运行作业	*		
2	剩余时间	0	7	3
2	运行作业		*	
3	剩余时间		6	3
3	运行作业			*
4	剩余时间		6	2
4	运行作业			*
5	剩余时间		6	1
5	运行作业			*
6	剩余时间		6	0
6	运行作业		*	
7	剩余时间		5	
7	运行作业		*	
8	剩余时间		4	
8	运行作业		*	
9	剩余时间		3	
9	运行作业		*	
10	剩余时间		2	
10	运行作业		*	
11	剩余时间		1	
11	运行作业		*	
12	剩余时间		0	

添加-c 参数:

```

** Solutions **
Random 651593 -> Winning ticket 119 (of 153) -> Run 2
Jobs: ( job:0 timeleft:1 tix:84 ) ( job:1 timeleft:7 tix:25 ) (* job:2 timeleft:4 tix:44 )
Random 788724 -> Winning ticket 9 (of 153) -> Run 0
Jobs: (* job:0 timeleft:1 tix:84 ) ( job:1 timeleft:7 tix:25 ) ( job:2 timeleft:3 tix:44 )
--> JOB 0 DONE at time 2
Random 93859 -> Winning ticket 19 (of 69) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:7 tix:25 ) ( job:2 timeleft:3 tix:44 )
Random 28347 -> Winning ticket 57 (of 69) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:6 tix:25 ) (* job:2 timeleft:3 tix:44 )
Random 835765 -> Winning ticket 37 (of 69) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:6 tix:25 ) (* job:2 timeleft:2 tix:44 )
Random 432767 -> Winning ticket 68 (of 69) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:6 tix:25 ) (* job:2 timeleft:1 tix:44 )
--> JOB 2 DONE at time 6
Random 762280 -> Winning ticket 5 (of 25) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:6 tix:25 ) ( job:2 timeleft:0 tix:--- )
Random 2106 -> Winning ticket 6 (of 25) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:5 tix:25 ) ( job:2 timeleft:0 tix:--- )
Random 445387 -> Winning ticket 12 (of 25) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:4 tix:25 ) ( job:2 timeleft:0 tix:--- )
Random 721540 -> Winning ticket 15 (of 25) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:3 tix:25 ) ( job:2 timeleft:0 tix:--- )
Random 228762 -> Winning ticket 12 (of 25) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:2 tix:25 ) ( job:2 timeleft:0 tix:--- )
Random 945271 -> Winning ticket 21 (of 25) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:1 tix:25 ) ( job:2 timeleft:0 tix:--- )
--> JOB 1 DONE at time 12

```

经验证正确。

随机种子为 2:

```

yangjie@ubuntu:~/share/Operating-Systems-Three-Easy-Pieces-NOTES-main/09.第九章-
调度_比例份额$ python2 lottery.py -j 3 -s 2
ARG jlist
ARG jobs 3
ARG maxlen 10
ARG maxticket 100
ARG quantum 1
ARG seed 2

Here is the job list, with the run time of each job:
  Job 0 ( length = 9, tickets = 94 )
  Job 1 ( length = 8, tickets = 73 )
  Job 2 ( length = 6, tickets = 30 )

Here is the set of random numbers you will need (at most):
Random 605944
Random 606802
Random 581204
Random 158383
Random 430670
Random 393532
Random 723012
Random 994820
Random 949396
Random 544177
Random 444854
Random 268241
Random 35924
Random 27444
Random 464894
Random 318465
Random 380015
Random 891790
Random 525753
Random 560510
Random 236123
Random 23858
Random 325143

```

作业 0 (length=9, 彩票编号:0-93)

作业 1 (length=8, 彩票编号:94-166)

作业 2 (length=6, 彩票编号:167-196)

时间片为 1

$605944 \% 197 = 169$, 获奖彩票编号为 169, 所以运行作业 2

$606802 \% 197 = 42$, 获奖彩票编号为 42, 所以运行作业 0

$581204 \% 197 = 54$, 获奖彩票编号为 54, 所以运行作业 0

以此类推……

得出下表:

时间线		job0	job1	job2
0	剩余时间	9	8	6
0	运行作业			*
1	剩余时间	9	8	5
1	运行作业	*		
2	剩余时间	8	8	5
2	运行作业	*		
3	剩余时间	7	8	5
3	运行作业			*
4	剩余时间	7	8	4
4	运行作业	*		
5	剩余时间	6	8	4
5	运行作业		*	
6	剩余时间	6	7	4
6	运行作业	*		
7	剩余时间	5	7	4
7	运行作业			*
8	剩余时间	5	7	3
8	运行作业	*		
9	剩余时间	4	7	3
9	运行作业	*		
10	剩余时间	3	7	3
10	运行作业	*		
11	剩余时间	2	7	3
11	运行作业		*	
12	剩余时间	2	6	3
12	运行作业	*		
13	剩余时间	1	6	3
13	运行作业	*		
14	剩余时间	0	6	3
14	运行作业		*	
15	剩余时间		5	3
15	运行作业			*
16	剩余时间		5	2
16	运行作业		*	
17	剩余时间		4	2
17	运行作业		*	
18	剩余时间		3	2
18	运行作业		*	
19	剩余时间		2	2
19	运行作业			*
20	剩余时间		2	1
20	运行作业		*	
21	剩余时间		1	1
21	运行作业		*	
22	剩余时间		0	1
22	运行作业			*
23	剩余时间			0

添加-c 参数:

```
** Solutions **
Random 605944 -> Winning ticket 169 (of 197) -> Run 2
Jobs: ( job:0 timeleft:9 tix:94 ) ( job:1 timeleft:8 tix:73 ) (* job:2 timeleft:6 tix:30 )
Random 606802 -> Winning ticket 42 (of 197) -> Run 0
Jobs: (* job:0 timeleft:9 tix:94 ) ( job:1 timeleft:8 tix:73 ) ( job:2 timeleft:5 tix:30 )
Random 581204 -> Winning ticket 54 (of 197) -> Run 0
Jobs: (* job:0 timeleft:8 tix:94 ) ( job:1 timeleft:8 tix:73 ) ( job:2 timeleft:5 tix:30 )
Random 158383 -> Winning ticket 192 (of 197) -> Run 2
Jobs: ( job:0 timeleft:7 tix:94 ) ( job:1 timeleft:8 tix:73 ) (* job:2 timeleft:5 tix:30 )
Random 430670 -> Winning ticket 28 (of 197) -> Run 0
Jobs: (* job:0 timeleft:7 tix:94 ) ( job:1 timeleft:8 tix:73 ) ( job:2 timeleft:4 tix:30 )
Random 393532 -> Winning ticket 123 (of 197) -> Run 1
Jobs: ( job:0 timeleft:6 tix:94 ) (* job:1 timeleft:8 tix:73 ) ( job:2 timeleft:4 tix:30 )
Random 723012 -> Winning ticket 22 (of 197) -> Run 0
Jobs: (* job:0 timeleft:6 tix:94 ) ( job:1 timeleft:7 tix:73 ) ( job:2 timeleft:4 tix:30 )
Random 994820 -> Winning ticket 167 (of 197) -> Run 2
Jobs: ( job:0 timeleft:5 tix:94 ) ( job:1 timeleft:7 tix:73 ) (* job:2 timeleft:4 tix:30 )
Random 949396 -> Winning ticket 53 (of 197) -> Run 0
Jobs: (* job:0 timeleft:5 tix:94 ) ( job:1 timeleft:7 tix:73 ) ( job:2 timeleft:3 tix:30 )
Random 544177 -> Winning ticket 63 (of 197) -> Run 0
Jobs: (* job:0 timeleft:4 tix:94 ) ( job:1 timeleft:7 tix:73 ) ( job:2 timeleft:3 tix:30 )
Random 444854 -> Winning ticket 28 (of 197) -> Run 0
Jobs: (* job:0 timeleft:3 tix:94 ) ( job:1 timeleft:7 tix:73 ) ( job:2 timeleft:3 tix:30 )
Random 268241 -> Winning ticket 124 (of 197) -> Run 1
Jobs: ( job:0 timeleft:2 tix:94 ) (* job:1 timeleft:7 tix:73 ) ( job:2 timeleft:3 tix:30 )
Random 35924 -> Winning ticket 70 (of 197) -> Run 0
Jobs: (* job:0 timeleft:2 tix:94 ) ( job:1 timeleft:6 tix:73 ) ( job:2 timeleft:3 tix:30 )
Random 27444 -> Winning ticket 61 (of 197) -> Run 0
Jobs: (* job:0 timeleft:1 tix:94 ) ( job:1 timeleft:6 tix:73 ) ( job:2 timeleft:3 tix:30 )
--> JOB 0 DONE at time 14
Random 464894 -> Winning ticket 55 (of 103) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:6 tix:73 ) ( job:2 timeleft:3 tix:30 )
Random 318465 -> Winning ticket 92 (of 103) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:5 tix:73 ) (* job:2 timeleft:3 tix:30 )
Random 380015 -> Winning ticket 48 (of 103) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:5 tix:73 ) ( job:2 timeleft:2 tix:30 )
Random 891790 -> Winning ticket 16 (of 103) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:4 tix:73 ) ( job:2 timeleft:2 tix:30 )
Random 525753 -> Winning ticket 41 (of 103) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:3 tix:73 ) ( job:2 timeleft:2 tix:30 )
Random 560510 -> Winning ticket 87 (of 103) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:2 tix:73 ) (* job:2 timeleft:2 tix:30 )
Random 236123 -> Winning ticket 47 (of 103) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:2 tix:73 ) ( job:2 timeleft:1 tix:30 )
Random 23858 -> Winning ticket 65 (of 103) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:1 tix:73 ) ( job:2 timeleft:1 tix:30 )
--> JOB 1 DONE at time 22
Random 325143 -> Winning ticket 3 (of 30) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:0 tix:--- ) (* job:2 timeleft:1 tix:30 )
--> JOB 2 DONE at time 23
```

经验证正确。

随机种子为 3:

```
yangjie@ubuntu:~/share/Operating-Systems-Three-Easy-Pieces-NOTES-main/09.第九章-调度_比例份额$ python2 1
ottery.py -j 3 -s 3
ARG jlist
ARG jobs 3
ARG maxlen 10
ARG maxticket 100
ARG quantum 1
ARG seed 3

Here is the job list, with the run time of each job:
Job 0 ( length = 2, tickets = 54 )
Job 1 ( length = 3, tickets = 60 )
Job 2 ( length = 6, tickets = 6 )

Here is the set of random numbers you will need (at most):
Random 13168
Random 837469
Random 259354
Random 234331
Random 995645
Random 470263
Random 836462
Random 476353
Random 639068
Random 150616
Random 634861
```

作业 0 (length=2, 彩票编号:0-53)

作业 1 (length=3, 彩票编号:54-113)

作业 2 (length=6, 彩票编号:114-119)

时间片为 1

13168%120=88, 获奖彩票编号为 88, 所以运行作业 1

837469%120=109, 获奖彩票编号为 109, 所以运行作业 1

259354%120=34, 获奖彩票编号为 34, 所以运行作业 0

以此类推……

得出下表:

时间线		job0	job1	job2
0	剩余时间	2	3	6
0	运行作业		*	
1	剩余时间	2	2	6
1	运行作业		*	
2	剩余时间	2	1	6
2	运行作业	*		
3	剩余时间	1	1	6
3	运行作业		*	
4	剩余时间	1	0	6
4	运行作业	*		
5	剩余时间	0		6
5	运行作业			*
6	剩余时间			5
6	运行作业			*
7	剩余时间			4
7	运行作业			*
8	剩余时间			3
8	运行作业			*
9	剩余时间			2
9	运行作业			*
10	剩余时间			1
10	运行作业			*
11	剩余时间			0

添加-c 参数:

```
** Solutions **
Random 13168 -> Winning ticket 88 (of 120) -> Run 1
Jobs: ( job:0 timeleft:2 tix:54 ) (* job:1 timeleft:3 tix:60 ) ( job:2 timeleft:6 tix:6 )
Random 837469 -> Winning ticket 109 (of 120) -> Run 1
Jobs: ( job:0 timeleft:2 tix:54 ) (* job:1 timeleft:2 tix:60 ) ( job:2 timeleft:6 tix:6 )
Random 259354 -> Winning ticket 34 (of 120) -> Run 0
Jobs: (* job:0 timeleft:2 tix:54 ) ( job:1 timeleft:1 tix:60 ) ( job:2 timeleft:6 tix:6 )
Random 234331 -> Winning ticket 91 (of 120) -> Run 1
Jobs: ( job:0 timeleft:1 tix:54 ) (* job:1 timeleft:1 tix:60 ) ( job:2 timeleft:6 tix:6 )
--> JOB 1 DONE at time 4
Random 995645 -> Winning ticket 5 (of 60) -> Run 0
Jobs: (* job:0 timeleft:1 tix:54 ) ( job:1 timeleft:0 tix:--- ) ( job:2 timeleft:6 tix:6 )
--> JOB 0 DONE at time 5
Random 470263 -> Winning ticket 1 (of 6) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:0 tix:--- ) (* job:2 timeleft:6 tix:6 )
Random 836462 -> Winning ticket 2 (of 6) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:0 tix:--- ) (* job:2 timeleft:5 tix:6 )
Random 476353 -> Winning ticket 1 (of 6) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:0 tix:--- ) (* job:2 timeleft:4 tix:6 )
Random 639068 -> Winning ticket 2 (of 6) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:0 tix:--- ) (* job:2 timeleft:3 tix:6 )
Random 150616 -> Winning ticket 4 (of 6) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:0 tix:--- ) (* job:2 timeleft:2 tix:6 )
Random 634861 -> Winning ticket 1 (of 6) -> Run 2
Jobs: ( job:0 timeleft:0 tix:--- ) ( job:1 timeleft:0 tix:--- ) (* job:2 timeleft:1 tix:6 )
--> JOB 2 DONE at time 11
```

经验证正确。

2. 现在运行两个具体的工作：每个长度为 10, 但是一个（工作 0）只有一张彩票，另一个（工作 1）有 100 张（-110:1, 10:100）。

彩票数量如此不平衡时会发生什么？在工作 1 完成之前，工作 0 是否会运行？多久？一般来说，这种彩票不平衡对彩票调度的行为有什么影响？

下图展示了随机种子为 1、2、3 时的模拟解：

随机种子为 1：

```
** Solutions **

Random 134364 -> Winning ticket 34 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:10 tix:100 )
Random 847434 -> Winning ticket 44 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:9 tix:100 )
Random 763775 -> Winning ticket 13 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:8 tix:100 )
Random 255069 -> Winning ticket 44 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:7 tix:100 )
Random 495435 -> Winning ticket 30 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:6 tix:100 )
Random 449491 -> Winning ticket 41 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:5 tix:100 )
Random 651593 -> Winning ticket 42 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:4 tix:100 )
Random 788724 -> Winning ticket 15 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:3 tix:100 )
Random 93859 -> Winning ticket 30 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:2 tix:100 )
Random 28347 -> Winning ticket 67 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:1 tix:100 )
--> JOB 1 DONE at time 10
Random 835765 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:10 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 432767 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:9 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 762280 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:8 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 2106 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:7 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 445387 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:6 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 721540 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:5 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 228762 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:4 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 945271 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:3 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 901428 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:2 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 30590 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:1 tix:1 ) ( job:1 timeleft:0 tix:--- )
--> JOB 0 DONE at time 20
```

随机种子为 2:

```
ARG jlist 10:1,10:100
ARG jobs 2
ARG maxlen 10
ARG maxticket 100
ARG quantum 1
ARG seed 2
```

Here is the job list, with the run time of each job:

```
Job 0 ( length = 10, tickets = 1 )
Job 1 ( length = 10, tickets = 100 )
```

**** Solutions ****

```
Random 956035 -> Winning ticket 70 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:10 tix:100 )
Random 947828 -> Winning ticket 44 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:9 tix:100 )
Random 56551 -> Winning ticket 92 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:8 tix:100 )
Random 84872 -> Winning ticket 32 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:7 tix:100 )
Random 835499 -> Winning ticket 27 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:6 tix:100 )
Random 735970 -> Winning ticket 84 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:5 tix:100 )
Random 669731 -> Winning ticket 0 (of 101) -> Run 0
Jobs: (* job:0 timeleft:10 tix:1 ) ( job:1 timeleft:4 tix:100 )
Random 308136 -> Winning ticket 86 (of 101) -> Run 1
Jobs: ( job:0 timeleft:9 tix:1 ) (* job:1 timeleft:4 tix:100 )
Random 605944 -> Winning ticket 45 (of 101) -> Run 1
Jobs: ( job:0 timeleft:9 tix:1 ) (* job:1 timeleft:3 tix:100 )
Random 606802 -> Winning ticket 95 (of 101) -> Run 1
Jobs: ( job:0 timeleft:9 tix:1 ) (* job:1 timeleft:2 tix:100 )
Random 581204 -> Winning ticket 50 (of 101) -> Run 1
Jobs: ( job:0 timeleft:9 tix:1 ) (* job:1 timeleft:1 tix:100 )
--> JOB 1 DONE at time 11
Random 158383 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:9 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 430670 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:8 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 393532 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:7 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 723012 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:6 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 994820 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:5 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 949396 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:4 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 544177 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:3 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 444854 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:2 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 268241 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:1 tix:1 ) ( job:1 timeleft:0 tix:--- )
--> JOB 0 DONE at time 20
```

随机种子为 3:


```

ARG jlist 10:1,10:100
ARG jobs 2
ARG maxlen 10
ARG maxticket 100
ARG quantum 1
ARG seed 3

Here is the job list, with the run time of each job:
Job 0 ( length = 10, tickets = 1 )
Job 1 ( length = 10, tickets = 100 )

** Solutions **

Random 237964 -> Winning ticket 8 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:10 tix:100 )
Random 544229 -> Winning ticket 41 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:9 tix:100 )
Random 369955 -> Winning ticket 93 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:8 tix:100 )
Random 603920 -> Winning ticket 41 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:7 tix:100 )
Random 625720 -> Winning ticket 25 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:6 tix:100 )
Random 65528 -> Winning ticket 80 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:5 tix:100 )
Random 13168 -> Winning ticket 38 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:4 tix:100 )
Random 837469 -> Winning ticket 78 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:3 tix:100 )
Random 259354 -> Winning ticket 87 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:2 tix:100 )
Random 234331 -> Winning ticket 11 (of 101) -> Run 1
Jobs: ( job:0 timeleft:10 tix:1 ) (* job:1 timeleft:1 tix:100 )
--> JOB 1 DONE at time 10
Random 995645 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:10 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 470263 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:9 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 836462 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:8 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 476353 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:7 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 639068 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:6 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 150616 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:5 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 634861 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:4 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 868046 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:3 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 523181 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:2 tix:1 ) ( job:1 timeleft:0 tix:--- )
Random 741252 -> Winning ticket 0 (of 1) -> Run 0
Jobs: (* job:0 timeleft:1 tix:1 ) ( job:1 timeleft:0 tix:--- )
--> JOB 0 DONE at time 20

```

可以看出彩票数量如此不平衡会导致作业 0 响应时间与周转时间可能非常长, 作业 1 完成前, 作业 0 可能会运行, 但概率非常小 (三次测试中只有第二次测试作业 0 在作业 1 完成前运行了一个时间片)。

彩票不平衡的调度导致彩票数少的作业**响应时间与周转时间变长**, 且彩票数量越悬殊, 一方的响应时间与周转时间相较另一方差距就越大。

3. 如果运行两个长度为 100 的工作, 都有 100 张彩票 (-1100:100, 100:100), 调度程序有多不公平? 运行一些不同的随机种子来确定 (概率上的) 答案。不公平性取决于一项工作比另一项工作早完成多少。

时间片为 1:

随机种子为 1:

```

ARG jllist 100:100,100:100
ARG jobs 2
ARG maxlen 10
ARG maxticket 100
ARG quantum 1
ARG seed 1

```

Here is the job list, with the run time of each job:

```

Job 0 ( length = 100, tickets = 100 )
Job 1 ( length = 100, tickets = 100 )

```

```

--> JOB 1 DONE at time 196
Random 104424 -> Winning ticket 24 (of 100) -> Run 0
Jobs: (* job:0 timeleft:4 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 665958 -> Winning ticket 58 (of 100) -> Run 0
Jobs: (* job:0 timeleft:3 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 296072 -> Winning ticket 72 (of 100) -> Run 0
Jobs: (* job:0 timeleft:2 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 499800 -> Winning ticket 0 (of 100) -> Run 0
Jobs: (* job:0 timeleft:1 tix:100 ) ( job:1 timeleft:0 tix:--- )
--> JOB 0 DONE at time 200

```

随机种子为 2:

```

ARG jllist 100:100,100:100
ARG jobs 2
ARG maxlen 10
ARG maxticket 100
ARG quantum 1
ARG seed 2

```

Here is the job list, with the run time of each job:

```

Job 0 ( length = 100, tickets = 100 )
Job 1 ( length = 100, tickets = 100 )

```

```

--> JOB 1 DONE at time 190
Random 581076 -> Winning ticket 76 (of 100) -> Run 0
Jobs: (* job:0 timeleft:10 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 51234 -> Winning ticket 34 (of 100) -> Run 0
Jobs: (* job:0 timeleft:9 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 418016 -> Winning ticket 16 (of 100) -> Run 0
Jobs: (* job:0 timeleft:8 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 525065 -> Winning ticket 65 (of 100) -> Run 0
Jobs: (* job:0 timeleft:7 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 181225 -> Winning ticket 25 (of 100) -> Run 0
Jobs: (* job:0 timeleft:6 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 93786 -> Winning ticket 86 (of 100) -> Run 0
Jobs: (* job:0 timeleft:5 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 802656 -> Winning ticket 56 (of 100) -> Run 0
Jobs: (* job:0 timeleft:4 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 366184 -> Winning ticket 84 (of 100) -> Run 0
Jobs: (* job:0 timeleft:3 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 519210 -> Winning ticket 10 (of 100) -> Run 0
Jobs: (* job:0 timeleft:2 tix:100 ) ( job:1 timeleft:0 tix:--- )
Random 921451 -> Winning ticket 51 (of 100) -> Run 0
Jobs: (* job:0 timeleft:1 tix:100 ) ( job:1 timeleft:0 tix:--- )
--> JOB 0 DONE at time 200

```

随机种子为 3:

```

ARG jllist 100:100,100:100
ARG jobs 2
ARG maxlen 10
ARG maxticket 100
ARG quantum 1
ARG seed 3

```

Here is the job list, with the run time of each job:

```

Job 0 ( length = 100, tickets = 100 )
Job 1 ( length = 100, tickets = 100 )

```

```

--> JOB 0 DONE at time 196
Random 289042 -> Winning ticket 42 (of 100) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:4 tix:100 )
Random 341069 -> Winning ticket 69 (of 100) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:3 tix:100 )
Random 227466 -> Winning ticket 66 (of 100) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:2 tix:100 )
Random 68067 -> Winning ticket 67 (of 100) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:1 tix:100 )
--> JOB 1 DONE at time 200

```

时间片为 50:

随机种子为 1:

```

ARG jlist 100:100,100:100
ARG jobs 2
ARG maxlen 10
ARG maxticket 100
ARG quantum 50
ARG seed 1

Here is the job list, with the run time of each job:
Job 0 ( length = 100, tickets = 100 )
Job 1 ( length = 100, tickets = 100 )

** Solutions **

Random 134364 -> Winning ticket 164 (of 200) -> Run 1
Jobs: ( job:0 timeleft:100 tix:100 ) (* job:1 timeleft:100 tix:100 )
Random 847434 -> Winning ticket 34 (of 200) -> Run 0
Jobs: (* job:0 timeleft:100 tix:100 ) ( job:1 timeleft:50 tix:100 )
Random 763775 -> Winning ticket 175 (of 200) -> Run 1
Jobs: ( job:0 timeleft:50 tix:100 ) (* job:1 timeleft:50 tix:100 )
--> JOB 1 DONE at time 150
Random 255069 -> Winning ticket 69 (of 100) -> Run 0
Jobs: (* job:0 timeleft:50 tix:100 ) ( job:1 timeleft:0 tix:--- )
--> JOB 0 DONE at time 200

```

随机种子为 2:

```

ARG jlist 100:100,100:100
ARG jobs 2
ARG maxlen 10
ARG maxticket 100
ARG quantum 50
ARG seed 2

Here is the job list, with the run time of each job:
Job 0 ( length = 100, tickets = 100 )
Job 1 ( length = 100, tickets = 100 )

** Solutions **

Random 956035 -> Winning ticket 35 (of 200) -> Run 0
Jobs: (* job:0 timeleft:100 tix:100 ) ( job:1 timeleft:100 tix:100 )
Random 947828 -> Winning ticket 28 (of 200) -> Run 0
Jobs: (* job:0 timeleft:50 tix:100 ) ( job:1 timeleft:100 tix:100 )
--> JOB 0 DONE at time 100
Random 56551 -> Winning ticket 51 (of 100) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:100 tix:100 )
Random 84872 -> Winning ticket 72 (of 100) -> Run 1
Jobs: ( job:0 timeleft:0 tix:--- ) (* job:1 timeleft:50 tix:100 )
--> JOB 1 DONE at time 200

```

随机种子为 3:

```

ARG jlist 100:100,100:100
ARG jobs 2
ARG maxlen 10
ARG maxticket 100
ARG quantum 50
ARG seed 3

Here is the job list, with the run time of each job:
  Job 0 ( length = 100, tickets = 100 )
  Job 1 ( length = 100, tickets = 100 )

** Solutions **

Random 237964 -> Winning ticket 164 (of 200) -> Run 1
  Jobs: ( job:0 timeleft:100 tix:100 ) (* job:1 timeleft:100 tix:100 )
Random 544229 -> Winning ticket 29 (of 200) -> Run 0
  Jobs: (* job:0 timeleft:100 tix:100 ) ( job:1 timeleft:50 tix:100 )
Random 369955 -> Winning ticket 155 (of 200) -> Run 1
  Jobs: ( job:0 timeleft:50 tix:100 ) (* job:1 timeleft:50 tix:100 )
--> JOB 1 DONE at time 150
Random 603920 -> Winning ticket 20 (of 100) -> Run 0
  Jobs: (* job:0 timeleft:50 tix:100 ) ( job:1 timeleft:0 tix:--- )
--> JOB 0 DONE at time 200

```

可以看出当时间片 ≤ 100 时,时间片越小,两项工作完成时间越接近,公平程度越高。从统计学角度也不难得出其中原因:时间片越小,随机次数越多,概率越准确(类比抛硬币)。