

# CloudSim 云任务调度实验

## 一、算法思路

### 1、循环调度算法

传统的循环调度策略的启发式云计算任务调度算法把一组任务顺序分配给一组虚拟机，尽量保证每个虚拟机运行相同数量的任务以平衡负载，但没有考虑任务的需求和虚拟机之间的差别。

### 2、贪心调度算法

传统的 Min-Min 启发式云计算任务调度算法采用先易后难的策略，先执行完成时间短的任务，然后执行完成时间长的任务，并采取贪心策略把每个任务优先指派给执行它最早完成的计算资源。

传统的 Max-Min 启发式云计算任务调度算法则恰恰相反，采用先难后易和贪心策略，每次选取完成时间最长的任务，再执行完成时间短的任务，并采取贪心策略把每个任务优先指派给执行它最早完成的计算资源。

### 3、遗传调度算法

启发式调度算法

## 二、参数配置

### 1、虚拟机配置

在 CloudSim 平台配置数据中心相关参数，其中虚拟机的关键参数如下表所示：

表 1 虚拟机参数信息

序号	MIPS	带宽
1	278	1000
2	289	1200
3	132	1100
4	209	1200
5	286	900

## 2、任务配置

初始 40 个任务配置方案:

表 2 云任务相关参数

任务数量	任务指令长度	任务文件长度
40	19365, 49809, 30218, 44157, 16754, 26785, 12348, 28894, 33889, 58967, 35045, 12236, 20085, 31123, 32227, 41727, 51017, 44787, 65854, 39836, 18336, 20047, 31493, 30727, 31017, 30218, 44157, 16754, 26785, 12348, 49809, 30218, 44157, 16754, 26785, 44157, 16754, 26785, 12348, 28894	30000, 50000, 10000, 40000, 20000, 41000, 27000, 43000, 36000, 33000, 23000, 22000, 41000, 42000, 24000, 23000, 36000, 42000, 46000, 33000, 23000, 22000, 41000, 42000, 50000, 10000, 40000, 20000, 41000, 10000, 40000, 20000, 41000, 27000, 30000, 50000, 10000, 40000, 20000, 17000

随后利用随机函数生成 500、1000、1500、2000 个任务,任务指令长度分布在 1000~5000,任务大小分布在 10000~30000 之间。

### 三、运行结果

### 1. 对比运行时间和均衡度

(1) 任务数量 40 个

### ① 循环调度

id	success	time	error	total
28	SUCCESS	2	0	908.17
15	SUCCESS	2	0	917
35	SUCCESS	2	0	934.48
30	SUCCESS	2	0	954.81
23	SUCCESS	2	3	1002.47
13	SUCCESS	2	3	1010.05
27	SUCCESS	2	2	1015.38
8	SUCCESS	2	3	1049.76
3	SUCCESS	2	3	1148.02
12	SUCCESS	2	2	1192.03
18	SUCCESS	2	3	1251.83
37	SUCCESS	2	2	1496.55
7	SUCCESS	2	2	1576.43
2	SUCCESS	2	2	1616.55
22	SUCCESS	2	2	1645.53
32	SUCCESS	2	2	1837.41
17	SUCCESS	2	2	1842.18

VM0 executeTime:954.9130937176769

VM1 executeTime:818.7226487972055

VM2 executeTime:1842.2818181818182

VM3 executeTime:1251.9305422647528

VM4 executeTime:863.1149112110506

meanOfExecuteTimeOfVM:1146.1926028345008

LB:15.140624840702584

CloudSimExample1 finished!

② Min-min

```

22      SUCCESS      2      4      890.84      0.1      890.94
24      SUCCESS      2      3      894.59      0.1      894.69
19      SUCCESS      2      1      924.69      0.1      924.79
8       SUCCESS      2      3      935.82      0.1      935.92
26      SUCCESS      2      1      954.6       0.1      954.7
31      SUCCESS      2      2      965.83      0.1      965.93
35      SUCCESS      2      0      970.29      0.1      970.39
17      SUCCESS      2      0      974.83      0.1      974.93
16      SUCCESS      2      0      997.24      0.1      997.34
15      SUCCESS      2      4      998.19      0.1      998.29
3       SUCCESS      2      4      1015.18     0.1      1015.28
18      SUCCESS      2      1      1029.68     0.1      1029.78
32      SUCCESS      2      3      1034.07     0.1      1034.17
10      SUCCESS      2      2      1038.96     0.1      1039.06
1       SUCCESS      2      3      1061.12     0.1      1061.22
9       SUCCESS      2      4      1066.97     0.1      1067.07
30      SUCCESS      2      2      1150.81     0.1      1150.91
VM0 executeTime:997.3368032164888

VM1 executeTime:1029.77570514501

VM2 executeTime:1150.910606060606

VM3 executeTime:1061.215099084404

VM4 executeTime:1067.068245937551

meanOfExecuteTimeOFVM:1061.2612918888121

LB:14.56887979145145

CloudSimExample1 finished!

```

### ③ Max-min

```

24      SUCCESS      2      4      913.41      0.1      913.51
19      SUCCESS      2      0      923.79      0.1      923.89
8       SUCCESS      2      4      953.56      0.1      953.66
32      SUCCESS      2      0      954.88      0.1      954.98
1       SUCCESS      2      0      975.21      0.1      975.31
30      SUCCESS      2      2      988.63      0.1      988.73
26      SUCCESS      2      3      992.77      0.1      992.87
15      SUCCESS      2      1      1010.95     0.1      1011.05
16      SUCCESS      2      3      1025.59     0.1      1025.69
35      SUCCESS      2      1      1027.77     0.1      1027.87
3       SUCCESS      2      4      1061.27     0.1      1061.37
17      SUCCESS      2      4      1065.68     0.1      1065.78
9       SUCCESS      2      1      1079.01     0.1      1079.11
18      SUCCESS      2      4      1139.34     0.1      1139.44
VM0 executeTime:975.3120465710844

VM1 executeTime:1079.1117713282893

VM2 executeTime:988.728713237751

VM3 executeTime:1025.6940299001672

VM4 executeTime:1139.436946153464

meanOfExecuteTimeOFVM:1041.6567014381512

LB:14.43368768844713

CloudSimExample1 finished!

```

### ④ 遗传算法

## (2) 任务数量 100 个

### ① 循环调度

```

8       SUCCESS      2      3      250.72      0.1      250.82
27      循环调度, 任务4成功 SUCCESS      2      2      255.06      0.1      255.16
92      SUCCESS      2      2      260.23      0.1      260.33
72      SUCCESS      2      2      261.39      0.1      261.49
32      SUCCESS      2      2      300.3       0.1      300.4
2       SUCCESS      2      2      305.19      0.1      305.29
22      SUCCESS      2      2      307.31      0.1      307.41
7       SUCCESS      2      2      310.26      0.1      310.36
77      SUCCESS      2      2      334.72      0.1      334.82
37      SUCCESS      2      2      341.88      0.1      341.98
62      SUCCESS      2      2      350.06      0.1      350.16
97      SUCCESS      2      2      361.04      0.1      361.14
67      SUCCESS      2      2      384.13      0.1      384.23
12      SUCCESS      2      2      408         0.1      408.1
52      SUCCESS      2      2      419.81      0.1      419.91
57      SUCCESS      2      2      433.22      0.1      433.32
47      SUCCESS      2      2      434.47      0.1      434.57
42      SUCCESS      2      2      437.97      0.1      438.07
17      SUCCESS      2      2      438.54      0.1      438.64
82      SUCCESS      2      2      441.04      0.1      441.14
VM0 executeTime:212.6276238339472

VM1 executeTime:195.23799815844308

VM2 executeTime:441.14197790093294

VM3 executeTime:250.82379608275104

VM4 executeTime:191.99918159923374

meanOfExecuteTimeOFVM:258.36611551506155

LB:7.188408940997466

CloudSimExample1 finished!

```

### ② Min-min

```

38      SUCCESS      2      3      243.94      0.1      244.04
57      SUCCESS      2      3      251.68      0.1      251.78
17      SUCCESS      2      3      255.02      0.1      255.12
9       SUCCESS      2      3      256.95      0.1      257.05
70      SUCCESS      2      3      258.04      0.1      258.14
77      SUCCESS      2      2      261.24      0.1      261.34
97      SUCCESS      2      2      282.76      0.1      282.86
39      SUCCESS      2      2      295.48      0.1      295.58
13      SUCCESS      2      2      301.94      0.1      302.04
4       SUCCESS      2      2      314.56      0.1      314.66
78      SUCCESS      2      2      320.72      0.1      320.82
47      SUCCESS      2      2      333.58      0.1      333.68
20      SUCCESS      2      2      338.4       0.1      338.5
86      SUCCESS      2      2      340.41      0.1      340.51
VM0 executeTime:199.24408329648386

VM1 executeTime:238.41422079104655

VM2 executeTime:340.5084879941282

VM3 executeTime:258.13545488967674

VM4 executeTime:202.51681056921115

meanOfExecuteTimeOfVM:247.7638115081093

LB:7.039372294574415

CloudSimExample1 finished!

```

### ③ Max-min

```

70      SUCCESS      2      0      229.24      0.1      229.34
19      SUCCESS      2      1      230.55      0.1      230.65
42      SUCCESS      2      4      231.22      0.1      231.32
40      SUCCESS      2      4      232.11      0.1      232.21
82      SUCCESS      2      4      234.09      0.1      234.19
81      SUCCESS      2      4      234.48      0.1      234.58
57      SUCCESS      2      1      236.55      0.1      236.65
66      SUCCESS      2      2      236.92      0.1      237.02
16      SUCCESS      2      1      239.59      0.1      239.69
9       SUCCESS      2      1      241.82      0.1      241.92
90      SUCCESS      2      1      242.78      0.1      242.88
44      SUCCESS      2      1      243.39      0.1      243.49
65      SUCCESS      2      2      243.71      0.1      243.81
69      SUCCESS      2      2      246.21      0.1      246.31
VM0 executeTime:229.3399086266351

VM1 executeTime:243.4880369462506

VM2 executeTime:246.31379452200815

VM3 executeTime:226.65383189020045

VM4 executeTime:234.57768777984606

meanOfExecuteTimeOfVM:236.07465195298806

LB:6.071312130197377

CloudSimExample1 finished!

```

### ④ 遗传算法

```

82      SUCCESS      2      1      259.31      0.1      259.41
4       SUCCESS      2      3      259.89      0.1      259.99
56      SUCCESS      2      2      262.27      0.1      262.37
98      SUCCESS      2      2      266.12      0.1      266.22
39      SUCCESS      2      2      270.42      0.1      270.52
14      SUCCESS      2      2      271.08      0.1      271.18
57      SUCCESS      2      3      277.47      0.1      277.57
66      SUCCESS      2      2      279.75      0.1      279.85
65      SUCCESS      2      3      285.73      0.1      285.83
90      SUCCESS      2      3      287.76      0.1      287.86
70      SUCCESS      2      3      288.6       0.1      288.7
44      SUCCESS      2      3      289.02      0.1      289.12
VM0 executeTime:195.38156315840686

VM1 executeTime:259.412391457265

VM2 executeTime:279.85138667257604

VM3 executeTime:289.12392344497607

VM4 executeTime:190.38217617293722

meanOfExecuteTimeOfVM:242.83028818123225

LB:6.968935186687164

CloudSimExample1 finished!

```

## (3) 任务数量 150 个

### ① 循环调度

```
77 SUCCESS 2 2 489.03 0.1 489.13
37 SUCCESS 2 2 499.45 0.1 499.55
62 SUCCESS 2 2 511.73 0.1 511.83
97 SUCCESS 2 2 528.8 0.1 528.9
142 SUCCESS 2 2 540.42 0.1 540.52
137 SUCCESS 2 2 549.88 0.1 549.98
67 SUCCESS 2 2 563.13 0.1 563.23
12 SUCCESS 2 2 597.22 0.1 597.32
52 SUCCESS 2 2 614.95 0.1 615.05
147 SUCCESS 2 2 617.67 0.1 617.77
57 SUCCESS 2 2 634.06 0.1 634.16
47 SUCCESS 2 2 635.92 0.1 636.02
102 SUCCESS 2 2 640.62 0.1 640.72
42 SUCCESS 2 2 641.53 0.1 641.63
17 SUCCESS 2 2 642.39 0.1 642.49
117 SUCCESS 2 2 645.68 0.1 645.78
82 SUCCESS 2 2 646.54 0.1 646.64
VM0 executeTime:340.875140614781
VM1 executeTime:292.2098266924601
VM2 executeTime:646.6370813397131
VM3 executeTime:417.3512171698049
VM4 executeTime:312.37294137895424
meanOfExecuteTimeOFVM:401.88924143914267
LB:8.965369389368657
CloudSimExample1 finished!
```

## ② Min-min

```
42 SUCCESS 2 3 444.81 0.1 444.91
114 SUCCESS 2 3 446.97 0.1 447.07
9 SUCCESS 2 3 448.8 0.1 448.9
82 SUCCESS 2 3 450.02 0.1 450.12
70 SUCCESS 2 3 450.49 0.1 450.59
48 SUCCESS 2 2 466.29 0.1 466.39
50 SUCCESS 2 2 477.38 0.1 477.48
108 SUCCESS 2 2 484.05 0.1 484.15
123 SUCCESS 2 2 490.64 0.1 490.74
148 SUCCESS 2 2 501.29 0.1 501.39
102 SUCCESS 2 2 507.29 0.1 507.39
40 SUCCESS 2 2 509.9 0.1 510
117 SUCCESS 2 2 512.48 0.1 512.58
86 SUCCESS 2 2 513.79 0.1 513.89
VM0 executeTime:328.87107500602394
VM1 executeTime:354.93472955745773
VM2 executeTime:513.8943535703053
VM3 executeTime:450.5892344497608
VM4 executeTime:297.48593420625906
meanOfExecuteTimeOFVM:389.15506535796135
LB:8.822188678077127
CloudSimExample1 finished!
```

## ③ Max-min

```
119 SUCCESS 2 4 367.2 0.1 367.3
117 SUCCESS 2 0 367.42 0.1 367.52
144 SUCCESS 2 4 368.13 0.1 368.23
90 SUCCESS 2 0 368.3 0.1 368.4
118 SUCCESS 2 1 368.45 0.1 368.55
81 SUCCESS 2 0 368.67 0.1 368.77
100 SUCCESS 2 4 368.97 0.1 369.07
44 SUCCESS 2 4 369.47 0.1 369.57
130 SUCCESS 2 1 370.56 0.1 370.66
114 SUCCESS 2 1 372.24 0.1 372.34
9 SUCCESS 2 1 374 0.1 374.1
8 SUCCESS 2 1 374.59 0.1 374.69
120 SUCCESS 2 1 375.46 0.1 375.56
69 SUCCESS 2 1 375.96 0.1 376.06
VM0 executeTime:368.76932630487187
VM1 executeTime:376.0638913263025
VM2 executeTime:361.84363804648024
VM3 executeTime:365.7639990296849
VM4 executeTime:369.5700256055712
meanOfExecuteTimeOFVM:368.4021760625821
LB:8.583730844598776
CloudSimExample1 finished!
```

## ④ 遗传算法

```

39      SUCCESS      2      2      451.29      0.1      451.39
14      SUCCESS      2      2      454.91      0.1      455.01
68      SUCCESS      2      2      455.02      0.1      455.12
64      SUCCESS      2      2      458.77      0.1      458.87
12      SUCCESS      2      2      488.53      0.1      488.63
149     SUCCESS      2      2      490.12      0.1      490.22
11      SUCCESS      2      2      497.61      0.1      497.71
124     SUCCESS      2      2      499.62      0.1      499.72
57      SUCCESS      2      2      510.71      0.1      510.81
121     SUCCESS      2      2      512.03      0.1      512.13
118     SUCCESS      2      2      512.8       0.1      512.9
20      SUCCESS      2      2      514.7       0.1      514.8
VM0 executeTime:326.677987332622

VM1 executeTime:382.6814142149965

VM2 executeTime:514.7957735247209

VM3 executeTime:431.28421052631586

VM4 executeTime:285.32653216388417

meanOfExecuteTimeOFVM:388.1531835525078

LB:8.810824973321258

CloudSimExample1 finished!

```

#### (4) 任务数量 200 个

##### ① 循环调度

```

12      SUCCESS      2      2      807.36      0.1      807.46
52      SUCCESS      2      2      829.02      0.1      829.12
147     SUCCESS      2      2      832.43      0.1      832.53
167     SUCCESS      2      2      849.02      0.1      849.92
57      SUCCESS      2      2      853.09      0.1      853.19
47      SUCCESS      2      2      855.27      0.1      855.37
102     SUCCESS      2      2      860.9       0.1      861
42      SUCCESS      2      2      862.04      0.1      862.14
17      SUCCESS      2      2      863.19      0.1      863.29
197     SUCCESS      2      2      866.71      0.1      866.81
117     SUCCESS      2      2      867.65      0.1      867.75
82      SUCCESS      2      2      868.51      0.1      868.61
VM0 executeTime:406.1535725236521

VM1 executeTime:396.04134109258683

VM2 executeTime:868.6075757575757

VM3 executeTime:555.8177033492824

VM4 executeTime:412.29110516934054

meanOfExecuteTimeOFVM:527.7822595784875

LB:10.27406696083384

CloudSimExample1 finished!

```

##### ② Min-min

```

90      SUCCESS      2      3      569.89      0.1      569.99
81      SUCCESS      2      3      570.37      0.1      570.47
198     SUCCESS      2      2      585.49      0.1      585.59
139     SUCCESS      2      2      593.02      0.1      593.12
146     SUCCESS      2      2      597.45      0.1      597.55
23      SUCCESS      2      2      617.36      0.1      617.46
4       SUCCESS      2      2      628.77      0.1      628.87
71      SUCCESS      2      2      638.4       0.1      638.5
163     SUCCESS      2      2      641.12      0.1      641.22
108     SUCCESS      2      2      647.73      0.1      647.83
19      SUCCESS      2      2      653.67      0.1      653.77
153     SUCCESS      2      2      664.49      0.1      664.59
66      SUCCESS      2      2      668.01      0.1      668.11
18      SUCCESS      2      2      674.19      0.1      674.29
169     SUCCESS      2      2      677.08      0.1      677.18
117     SUCCESS      2      2      679.12      0.1      679.22
70      SUCCESS      2      2      680.72      0.1      680.82
VM0 executeTime:419.53884892086336

VM1 executeTime:475.167642367952

VM2 executeTime:680.8216905901115

VM3 executeTime:570.4732057416268

VM4 executeTime:395.2231415309416

meanOfExecuteTimeOFVM:508.2449058302991

LB:10.082111939770348

CloudSimExample1 finished!

```

##### ③ Max-min

```

117      SUCCESS      2      3      483.23      0.1      483.33
40       SUCCESS      2      Max-Min, 任务数200 483.34      0.1      483.44
100      SUCCESS      2      3      484.74      0.1      484.84
191      SUCCESS      2      3      485.19      0.1      485.29
119      SUCCESS      2      1      485.32      0.1      485.42
20       SUCCESS      2      0      485.43      0.1      485.53
9        SUCCESS      2      1      485.83      0.1      485.93
65       SUCCESS      2      0      486.45      0.1      486.55
8        SUCCESS      2      0      487.09      0.1      487.19
82       SUCCESS      2      1      487.2      0.1      487.3
70       SUCCESS      2      1      487.85      0.1      487.95
86       SUCCESS      2      0      488.04      0.1      488.14
44       SUCCESS      2      1      488.16      0.1      488.26
69       SUCCESS      2      0      488.54      0.1      488.64
VM0 executeTime:488.6405191693073

VM1 executeTime:488.2556270829764

VM2 executeTime:456.32269457161544

VM3 executeTime:485.294918611691

VM4 executeTime:480.76795417569286

meanOfExecuteTimeOfVM:479.8563427222565

LB:9.796492665462027

CloudSimExample1 finished!

```

#### ④ 遗传算法

```

19       SUCCESS      2      GA,任务数200 592.57      0.1      592.67
147      SUCCESS      2      2      593.72      0.1      593.82
121      SUCCESS      2      3      593.85      0.1      593.95
102      SUCCESS      2      3      596.92      0.1      597.02
42       SUCCESS      2      3      597.64      0.1      597.74
20       SUCCESS      2      3      600.78      0.1      600.88
119      SUCCESS      2      3      601.34      0.1      601.44
65       SUCCESS      2      3      601.67      0.1      601.77
82       SUCCESS      2      3      602.29      0.1      602.39
18       SUCCESS      2      2      605      0.1      605.1
16       SUCCESS      2      2      605.48      0.1      605.58
69       SUCCESS      2      2      609.6      0.1      609.7
VM0 executeTime:429.9725603046974

VM1 executeTime:461.5892606634547

VM2 executeTime:609.6952472089315

VM3 executeTime:602.3922169059011

VM4 executeTime:408.3916341553184

meanOfExecuteTimeOfVM:502.4081838476606

LB:10.024052911349386

CloudSimExample1 finished!

```

### (5) 任务数量 300 个

#### ① 循环调度

```

167      SUCCESS      2      循环调度, 任务数300 1299.77      0.1      1299.87
57       SUCCESS      2      2      1304.27      0.1      1304.37
47       SUCCESS      2      2      1307.38      0.1      1307.48
102      SUCCESS      2      2      1315.83      0.1      1315.93
42       SUCCESS      2      2      1317.65      0.1      1317.75
17       SUCCESS      2      2      1319.67      0.1      1319.77
197      SUCCESS      2      2      1326.71      0.1      1326.81
242      SUCCESS      2      2      1327.43      0.1      1327.53
117      SUCCESS      2      2      1328.73      0.1      1328.83
282      SUCCESS      2      2      1329.6      0.1      1329.7
292      SUCCESS      2      2      1329.72      0.1      1329.82
82       SUCCESS      2      2      1330.23      0.1      1330.33
VM0 executeTime:632.3484606293616

VM1 executeTime:599.336027056014

VM2 executeTime:1330.3272727272722

VM3 executeTime:841.5357747515642

VM4 executeTime:632.6822368531379

meanOfExecuteTimeOfVM:807.24595440347

LB:12.706265811822686

CloudSimExample1 finished!

```

#### ② Min-min

```

159      SUCCESS      2      2      955.25      0.1      955.35
217      SUCCESS      2      2      967.98      0.1      968.08
95      SUCCESS      2      2      971.39      0.1      971.49
78      SUCCESS      2      2      977.01      0.1      977.11
11      SUCCESS      2      2      987.45      0.1      987.55
52      SUCCESS      2      2      993.36      0.1      993.46
222     SUCCESS      2      2      997.94      0.1      998.04
188     SUCCESS      2      2      1008.09      0.1      1008.19
89      SUCCESS      2      2      1015.32      0.1      1015.42
285     SUCCESS      2      2      1022.41      0.1      1022.51
42      SUCCESS      2      2      1029.67      0.1      1029.77
40      SUCCESS      2      2      1033.54      0.1      1033.64
20      SUCCESS      2      2      1036.53      0.1      1036.63
65      SUCCESS      2      2      1038.74      0.1      1038.84
282     SUCCESS      2      2      1040.02      0.1      1040.12
120     SUCCESS      2      2      1041.98      0.1      1042.08
191     SUCCESS      2      2      1042.63      0.1      1042.73
VM0 executeTime:654.7028041474372
VM1 executeTime:700.9465601053474
VM2 executeTime:1042.7287878788
VM3 executeTime:889.7168261562998
VM4 executeTime:605.7084649539304
meanOfExecuteTimeOFVM:778.7606886483605
LB:12.480069620385622
CloudSimExample1 finished!

```

### ③ Max-min

```

120      SUCCESS      2      0      738.05      0.1      738.15
81      SUCCESS      2      4      738.18      0.1      738.28
292      SUCCESS      2      1      738.29      0.1      738.39
288      SUCCESS      2      4      738.4      0.1      738.5
235      SUCCESS      2      0      738.51      0.1      738.61
44      SUCCESS      2      0      738.76      0.1      738.86
221      SUCCESS      2      2      739      0.1      739.1
200      SUCCESS      2      1      739.8      0.1      739.9
70      SUCCESS      2      1      740.32      0.1      740.42
234      SUCCESS      2      1      740.56      0.1      740.66
223      SUCCESS      2      1      740.77      0.1      740.87
282      SUCCESS      2      2      740.97      0.1      741.07
250      SUCCESS      2      2      743.27      0.1      743.37
69      SUCCESS      2      2      744.21      0.1      744.31
VM0 executeTime:738.8558430119533
VM1 executeTime:740.866433344343
VM2 executeTime:744.3058272837369
VM3 executeTime:729.4986111780433
VM4 executeTime:738.4976415731044
meanOfExecuteTimeOFVM:738.4048712782362
LB:12.15240610972359
CloudSimExample1 finished!

```

### ④ 遗传算法

```

57      SUCCESS      2      3      833.3      0.1      833.4
47      SUCCESS      2      3      834.87      0.1      834.97
285     SUCCESS      2      3      835.44      0.1      835.54
16      SUCCESS      2      3      840.09      0.1      840.19
275     SUCCESS      2      2      843.32      0.1      843.42
233     SUCCESS      2      3      844.61      0.1      844.71
65      SUCCESS      2      3      845.05      0.1      845.15
144     SUCCESS      2      3      845.84      0.1      845.94
235     SUCCESS      2      2      846.13      0.1      846.23
223     SUCCESS      2      2      846.79      0.1      846.89
100     SUCCESS      2      3      846.99      0.1      847.09
70      SUCCESS      2      3      847.25      0.1      847.35
VM0 executeTime:732.5565485984419
VM1 executeTime:702.9423285657165
VM2 executeTime:846.8886590602381
VM3 executeTime:847.3479892037786
VM4 executeTime:649.3683703148065
meanOfExecuteTimeOFVM:755.8207791485962
LB:12.290883319077057
CloudSimExample1 finished!

```

## (6) 任务数量 400 个

### ① 循环调度



42	SUCCESS	2	2	1801.88	0.1	1801.98
17	SUCCESS	2	2	1805.05	0.1	1805.15
342	SUCCESS	2	2	1807.77	0.1	1807.87
197	SUCCESS	2	2	1815.89	0.1	1815.99
242	SUCCESS	2	2	1817.04	0.1	1817.14
397	SUCCESS	2	2	1817.25	0.1	1817.35
117	SUCCESS	2	2	1819.02	0.1	1819.12
282	SUCCESS	2	2	1820.46	0.1	1820.56
292	SUCCESS	2	2	1820.7	0.1	1820.8
322	SUCCESS	2	2	1821.02	0.1	1821.12
82	SUCCESS	2	2	1821.83	0.1	1821.93
352	SUCCESS	2	2	1822.33	0.1	1822.43

VM0 executeTime:833.7928686580916

VM1 executeTime:822.3125534299651

VM2 executeTime:1822.4257575757574

VM3 executeTime:1140.6421690590107

VM4 executeTime:852.296247086247

meanOfExecuteTimeOfVM:1094.2939191618143

LB:14.79387656540242

CloudSimExample1 finished!

## ② Min-min

387	SUCCESS	2	2	1282.07	0.1	1282.17
124	SUCCESS	2	2	1292.11	0.1	1292.21
281	SUCCESS	2	2	1295.18	0.1	1295.28
181	SUCCESS	2	2	1306.42	0.1	1306.52
188	SUCCESS	2	2	1313.12	0.1	1313.22
167	SUCCESS	2	2	1323.21	0.1	1323.31
386	SUCCESS	2	2	1328.8	0.1	1328.9
121	SUCCESS	2	2	1332.2	0.1	1332.3
118	SUCCESS	2	2	1335.68	0.1	1335.78
17	SUCCESS	2	2	1343.2	0.1	1343.3
339	SUCCESS	2	2	1346.43	0.1	1346.53
221	SUCCESS	2	2	1351.3	0.1	1351.4
398	SUCCESS	2	2	1352.51	0.1	1352.61
282	SUCCESS	2	2	1354.17	0.1	1354.27
388	SUCCESS	2	2	1356.06	0.1	1356.16
70	SUCCESS	2	2	1357.42	0.1	1357.52
288	SUCCESS	2	2	1357.93	0.1	1358.03

VM0 executeTime:894.4953717026378

VM1 executeTime:949.3931739540739

VM2 executeTime:1358.0318181818184

VM3 executeTime:1174.3257036476086

VM4 executeTime:854.5723073128113

meanOfExecuteTimeOfVM:1046.16367495979

LB:14.464879363200994

CloudSimExample1 finished!

## ③ Max-min

191	SUCCESS	2	1	997.49	0.1	997.59
395	SUCCESS	2	1	997.6	0.1	997.7
352	SUCCESS	2	3	998.18	0.1	998.28
100	SUCCESS	2	4	998.51	0.1	998.61
81	SUCCESS	2	3	998.62	0.1	998.72
86	SUCCESS	2	4	998.76	0.1	998.86
44	SUCCESS	2	3	999.05	0.1	999.15
70	SUCCESS	2	4	999.16	0.1	999.26
365	SUCCESS	2	4	999.5	0.1	999.6
275	SUCCESS	2	2	999.61	0.1	999.71
223	SUCCESS	2	4	999.72	0.1	999.82
388	SUCCESS	2	2	1001.56	0.1	1001.66
235	SUCCESS	2	2	1003.03	0.1	1003.13
69	SUCCESS	2	2	1003.75	0.1	1003.85

VM0 executeTime:994.8362079440474

VM1 executeTime:997.7044762503932

VM2 executeTime:1003.8482121715217

VM3 executeTime:999.1452517985612

VM4 executeTime:999.8179091412186

meanOfExecuteTimeOfVM:999.0704114611484

LB:14.135560911836137

CloudSimExample1 finished!

## ④ 遗传算法

```
201      SUCCESS      2      2      1144.37      0.1      1144.47
221      SUCCESS      2      2      1146.69      0.1      1146.79
351      SUCCESS      2      3      1154.35      0.1      1154.45
9        SUCCESS      2      3      1162.65      0.1      1162.75
144      SUCCESS      2      3      1164.64      0.1      1164.74
323      SUCCESS      2      3      1167.35      0.1      1167.45
90       SUCCESS      2      3      1167.5      0.1      1167.6
352      SUCCESS      2      3      1168.84      0.1      1168.94
244      SUCCESS      2      3      1168.99      0.1      1169.09
191      SUCCESS      2      3      1169.94      0.1      1170.04
365      SUCCESS      2      3      1170.05      0.1      1170.15
223      SUCCESS      2      3      1170.24      0.1      1170.34
VM0 executeTime:957.9973727919206

VM1 executeTime:1008.7013043934152

VM2 executeTime:1146.7925358851674

VM3 executeTime:1170.3439712918662

VM4 executeTime:833.3986242821261

meanOfExecuteTimeOFVM:1023.4467617288992

LB:14.306968663758925

CloudSimExample1 finished!
```

## (7) 任务数量 500 个

### ① 循环调度

```
427      SUCCESS      2      2      2314.3      0.1      2314.4
197      SUCCESS      2      2      2315.71      0.1      2315.81
242      SUCCESS      2      2      2317.15      0.1      2317.25
397      SUCCESS      2      2      2317.42      0.1      2317.52
117      SUCCESS      2      2      2319.79      0.1      2319.89
282      SUCCESS      2      2      2321.8      0.1      2321.9
292      SUCCESS      2      2      2322.17      0.1      2322.27
322      SUCCESS      2      2      2322.7      0.1      2322.8
82       SUCCESS      2      2      2324.3      0.1      2324.4
352      SUCCESS      2      2      2325.8      0.1      2325.9
412      SUCCESS      2      2      2326.33      0.1      2326.43
457      SUCCESS      2      2      2326.44      0.1      2326.54
VM0 executeTime:994.5878588349309

VM1 executeTime:1061.2174685849568

VM2 executeTime:2326.543333333336

VM3 executeTime:1434.7634560176662

VM4 executeTime:1066.6666294241172

meanOfExecuteTimeOFVM:1376.7557492390013

LB:16.593708140370563

CloudSimExample1 finished!
```

### ② Min-min

```
310      SUCCESS      2      2      1625.91      0.1      1626.01
153      SUCCESS      2      2      1639.97      0.1      1640.07
111      SUCCESS      2      2      1644.4      0.1      1644.5
57       SUCCESS      2      2      1651.83      0.1      1651.93
471      SUCCESS      2      2      1654.88      0.1      1654.98
423      SUCCESS      2      2      1659.97      0.1      1660.07
464      SUCCESS      2      2      1666.64      0.1      1666.74
489      SUCCESS      2      2      1670.88      0.1      1670.98
366      SUCCESS      2      2      1672.72      0.1      1672.82
114      SUCCESS      2      2      1676.23      0.1      1676.33
221      SUCCESS      2      2      1681.17      0.1      1681.27
65       SUCCESS      2      2      1682.58      0.1      1682.68
275      SUCCESS      2      2      1684.51      0.1      1684.61
82       SUCCESS      2      2      1686.93      0.1      1687.03
352      SUCCESS      2      2      1688.43      0.1      1688.53
81       SUCCESS      2      2      1689.11      0.1      1689.21
395      SUCCESS      2      2      1689.56      0.1      1689.66
VM0 executeTime:1135.8110313338707

VM1 executeTime:1249.540972224521

VM2 executeTime:1689.6606060606064

VM3 executeTime:1438.123923444976

VM4 executeTime:1030.410410154026

meanOfExecuteTimeOFVM:1308.7093886436

LB:16.178438667829475

CloudSimExample1 finished!
```

### ③ Max-min

```
365      SUCCESS      2      4      1253.58      0.1      1253.68
483      SUCCESS      2      4      1253.73      0.1      1253.83
144      SUCCESS      2      0      1254.57      0.1      1254.67
322      SUCCESS      2      0      1255.24      0.1      1255.34
352      SUCCESS      2      2      1255.49      0.1      1255.59
441      SUCCESS      2      2      1256.23      0.1      1256.33
223      SUCCESS      2      2      1256.81      0.1      1256.91
90       SUCCESS      2      0      1256.92      0.1      1257.02
200      SUCCESS      2      0      1257.65      0.1      1257.75
250      SUCCESS      2      0      1258.18      0.1      1258.28
493      SUCCESS      2      0      1258.65      0.1      1258.75
234      SUCCESS      2      0      1258.9       0.1      1259
288      SUCCESS      2      0      1259.13      0.1      1259.23
69       SUCCESS      2      0      1259.26      0.1      1259.36
VM0 executeTime:1259.3556623406953

VM1 executeTime:1248.234134947226

VM2 executeTime:1256.911129966595

VM3 executeTime:1243.3203422168465

VM4 executeTime:1253.8317752685352

meanOfExecuteTimeOFVM:1252.3306089479795

LB:15.826121501795564

CloudSimExample1 finished!
```

#### ④ 遗传算法

```
471      SUCCESS      2      2      1571.12      0.1      1571.22
285      SUCCESS      2      2      1573.37      0.1      1573.47
396      SUCCESS      2      2      1576.1       0.1      1576.2
433      SUCCESS      2      2      1585.16      0.1      1585.26
338      SUCCESS      2      2      1589.77      0.1      1589.87
253      SUCCESS      2      2      1589.88      0.1      1589.98
169      SUCCESS      2      2      1590.33      0.1      1590.43
242      SUCCESS      2      2      1593.82      0.1      1593.92
461      SUCCESS      2      2      1595.18      0.1      1595.28
8        SUCCESS      2      2      1596.09      0.1      1596.19
333      SUCCESS      2      2      1596.45      0.1      1596.55
235      SUCCESS      2      2      1597.6       0.1      1597.7
VM0 executeTime:1156.9167475727863

VM1 executeTime:1194.8296197702186

VM2 executeTime:1597.7048165869217

VM3 executeTime:1488.3686921850078

VM4 executeTime:1071.2152450291317

meanOfExecuteTimeOFVM:1301.8070242288131

LB:16.135718293455753

CloudSimExample1 finished!
```

## 2. 绘制表格

表 3 任务执行时间

策略 \ 任务数	40	100	150	200	300	400	500
循环	1842.282	441.142	646.637	868.608	1330.327	1822.426	2326.543
Min-Min	1150.911	340.508	513.894	680.822	1042.729	1358.032	1689.661
Max-min	1139.437	246.314	376.064	488.641	744.306	1003.848	1259.356
GA	1191.208	289.124	514.796	609.695	847.348	1170.343	1597.705

表 4 任务均衡度

策略 \ 任务数	40	100	150	200	300	400	500
循环	15.146	7.188	8.965	10.274	12.706	14.794	16.594
Min-Min	14.569	7.039	8.822	10.082	12.480	14.465	16.178
Max-min	14.434	6.871	8.583	9.796	12.152	14.136	15.826
GA	14.534	6.969	8.811	10.024	12.295	14.307	16.135