# Cost efficient Job Scheduler for Distributed Systems

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# Introduction:

Through the process of creating the three base-line algorithms for our job scheduler, it is evident that these algorithms are not optimal, and while they do a semi decent job at scheduling jobs, they are not the most efficient algorithms to be running if this project were to be pushed to a real environment. A post analysis of the three-baseline algorithm clearly shows that while the avg waiting time, avg execution time and turnover time are semi decent, the cost of running these servers using these algorithms would be detrimental to someone actually using this software. In order to fix this problem, a new scheduling algorithm will be created that will run similar to that of the best fit algorithm, however this new scheduling algorithm will improve mainly upon the total cost when running these jobs.

## Problem definition:

This new algorithm’s objective is to be the new baseline algorithm with the goal of being an entry level algorithm for those creating a start-up or companies without the financial investment to be renting hundreds of servers, and spending thousands on jobs that have the capability to run much cheaper. In comparison to the three baseline algorithms that were created, it’s noticeable that while each algorithm has a use in a particular scenario, none focus on limiting server usage alongside cost. Effectively this new algorithm, would be the cost-efficient algorithm in which to run as it would use the least number of servers than any other algorithm and it would also run far cheaper than the three baseline algorithms. It should also be noted while the all to largest algorithm should run cheaper, it will run extremely slowly as you would need to wait on jobs to complete in order to run the next.

## Algorithm description:

The way in which this new cost-efficient algorithm differs from the three baseline algorithms in terms of code, is that while the three baseline algorithms check if the ‘current’ server has the available resources to run the ‘current’ job , the new algorithm will skip this step and will in turn, calculate the fitness level and assign jobs to servers that originally held the closest fitness level to 0. This means that if a server originally had the exact resources to run a job, it would run that job and while this job was running another job came long which also had the exact same resources as the previously mentioned server, this new job would also be assigned to said server. If by some chance something was missed and there was no server to run the job, the algorithm would go to its backup algorithm in which it will check all servers that could originally run the job, and get the server which has a closest fitness to 0.

### Pseudo code: cost efficient algorithm

For a given job ji,

1. set currentFit = to a very high number (INT\_MAX)

2. obtain server information from system.xml or available resc commands

3. For each server type t, st, in the same order as system.xml

4. For each server i, st,i of server type st, until limit

5. Calculate the fitness level fst,I,ji – defined as current server cores – current job cores

6. if fitness level == 0 || fitness < currentFit

7. set currentFit to fitness level

8. return st,i

9. end if

10. end For

11. end For

12. if cost efficient match is found

13. return the server with the best cost efficiency

14. else

15. set minTime to a very low number (MIN\_VALUE)

16. set minAvail to a very low number (MIN\_VALUE)

17. For each server i, si until limit

18. calculate bad fitness level fsi,ji

19. set minTime = badfitness

20. set minAvail = servers availtime

21. set cost efficient server = si

22. return cost efficient server

### Comparisons on ds-config-s3-1.xml

### CEA

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Job ID | Job Requirements | Server no | Server Resources | Job Start | Server Resources | Job End |
| 0 | 1 200 1200 | #0 small | 84 1 4000 16000 | 24 | -1 0 3800 14800 | 19407 |
| 1 | 1 600 700 | #0 small | -1 0 3800 14800 | 19407 | -1 0 3400 15300 | 20502 |
| 2 | 1 600 800 | #0 small | -1 0 3800 14800 | 20502 | -1 0 3400 15200 | 22229 |
| 3 | 2 2100 1300 | #0 medium | 144 2 16000 64000 | 84 | -1 0 13900 62700 | 1377 |
| 4 | 2 1100 2400 | #0 medium | -1 0 13900 62700 | 1377 | -1 0 14900 61600 | 2688 |
| 5 | 1 100 1600 | #0 small | -1 0 3800 14800 | 22229 | -1 0 3900 15400 | 23789 |
| 6 | 1 600 1500 | #0 small | -1 0 3800 14800 | 23789 | -1 0 3400 15500 | 23800 |
| 7 | 2 500 400 | #0 medium | -1 0 13900 62700 | 2688 | -1 0 15500 64600 | 3709 |
| 8 | 2 500 2800 | #0 medium | -1 0 13900 62700 | 3709 | -1 0 15500 61200 | 49136 |
| 9 | 1 600 200 | #0 small | -1 0 3800 14800 | 23800 | -1 0 3400 15800 | 25497 |

#### FF

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Job ID | Job Requirements | Server no | Server Resources | Job Start | Server Resources | Job End |
| 0 | 1 200 1200 | #0 small | 84 1 4000 16000 | 24 | -1 0 3800 15800 | 19407 |
| 1 | 1 600 700 | #1 small | 137 1 4000 16000 | 77 | -1 0 3400 15300 | 1232 |
| 2 | 1 600 800 | #0 medium | 140 2 16000 64000 | 80 | -1 1 15400 64200 | 1867 |
| 3 | 2 2100 1300 | #1 medium | 144 2 16000 64000 | 84 | -1 0 12900 63700 | 1377 |
| 4 | 2 1100 2400 | #0 medium | -1 2 16000 64000 | 1867 | -1 0 11900 61600 | 3178 |
| 5 | 1 100 1600 | #0 medium | -1 2 16000 64000 | 3178 | -1 1 13900 63600 | 4738 |
| 6 | 1 600 1500 | #0 medium | -1 2 16000 64000 | 3178 | -1 0 13300 62100 | 3189 |
| 7 | 2 500 400 | #0 medium | -1 2 16000 64000 | 4738 | -1 0 13500 63600 | 5759 |
| 8 | 2 500 2800 | #0 medium | -1 2 16000 64000 | 5759 | -1 0 13500 61200 | 51186 |
| 9 | 1 600 200 | #0 medium | -1 2 16000 64000 | 51186 | -1 1 13400 63800 | 52883 |

#### BF

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Job ID | Job Requirements | Server no | Server Resources | Job Start | Server Resources | Job End |
| 0 | 1 200 1200 | #0 small | 84 1 4000 16000 | 24 | -1 0 3800 15800 | 19407 |
| 1 | 1 600 700 | #1 small | 137 1 4000 16000 | 77 | -1 0 3400 15300 | 1232 |
| 2 | 1 600 800 | #0 medium | 140 2 16000 64000 | 80 | -1 1 15400 64200 | 1867 |
| 3 | 2 2100 1300 | #1 medium | 144 2 16000 64000 | 84 | -1 0 12900 63700 | 1377 |
| 4 | 2 1100 2400 | #0 medium | -1 2 16000 64000 | 1867 | -1 0 14900 61600 | 3178 |
| 5 | 1 100 1600 | #0 medium | -1 2 16000 64000 | 3178 | -1 1 15900 63600 | 4738 |
| 6 | 1 600 1500 | #0 medium | -1 2 16000 64000 | 3178 | -1 0 15300 62100 | 3189 |
| 7 | 2 500 400 | #0 medium | -1 2 16000 64000 | 4738 | -1 0 15500 63600 | 5759 |
| 8 | 2 500 2800 | #0 medium | -1 2 16000 64000 | 5759 | -1 0 15500 61200 | 51186 |
| 9 | 1 600 200 | #0 medium | -1 2 16000 64000 | 51186 | -1 1 15400 63800 | 52883 |

#### WF

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Job ID | Job Requirements | Server no | Server Resources | Job Start | Server Resources | Job End |
| 0 | 1 200 1200 | #0 medium | 124 2 16000 64000 | 24 | -1 1 15800 63800 | 19407 |
| 1 | 1 600 700 | #1 medium | 137 2 16000 64000 | 77 | -1 1 15400 63300 | 1232 |
| 2 | 1 600 800 | #0 small | 120 1 4000 16000 | 80 | -1 0 3400 4200 | 1867 |
| 3 | 2 2100 1300 | #0 medium | -1 2 16000 64000 | 19407 | -1 0 13900 61600 | 20640 |
| 4 | 2 1100 2400 | #0 medium | -1 2 16000 64000 | 20640 | -1 0 14900 61600 | 21951 |
| 5 | 1 100 1600 | #0 medium | -1 2 16000 64000 | 21951 | -1 1 15900 62400 | 23511 |
| 6 | 1 600 1500 | #0 medium | -1 2 16000 64000 | 21951 | -1 0 15200 60900 | 21962 |
| 7 | 2 500 400 | #0 medium | -1 2 16000 64000 | 23511 | -1 0 15500 63600 | 24532 |
| 8 | 2 500 2800 | #0 medium | -1 2 16000 64000 | 24532 | -1 0 15500 61200 | 69959 |
| 9 | 1 600 200 | #0 medium | -1 2 16000 64000 | 69959 | -1 1 15400 63800 | 71656 |

### Price comparison:

The following table and graphs show the price comparison from ds-config-s3-1 -> ds-confog-s3-7.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Config File | FF | BF | WF | CEA |
| Ds-config-s3-1 | $13.86 | $13.86 | $15.99 | $6.86 |
| Ds-config-s3-2 | $2241.44 | $2274.35 | $2728.55 | $1133.19 |
| Ds-config-s3-3 | $27643.44 | $27738.16 | $29933.08 | $15785.06 |
| Ds-config-s3-4 | $572.01 | $568.64 | $598.86 | $138.24 |
| Ds-config-s3-5 | $389.26 | $249.43 | $357.49 | $86.04 |
| Ds-config-s3-6 | $1013.62 | $1026.81 | $998.22 | $444.90 |
| Ds-config-s3-7 | $16202.63 | $16082.36 | $20119.38 | $5853.90 |

## Implementation Details:

Throughout this implementation, data structures including that of an ArrayList containing server objects, an ArrayList containing strings and finally a hash set also containing strings have been used in creating the new algorithm.

The first ArrayList contains respectively all servers sent through the use sending the command RESC Capable to the server. When a new job is dispatched, this ArrayList will be cleared in order to get the updated servers and avoid any conflicts.

The second ArrayList contains all the current server types. This is done by using the hash set data structure previously mentioned, in which all server types are added hash set in order to avoid duplicate server types, and then from there added to the ArrayList.

## Evaluation:

As is evident from the tables and charts provided above, the new implementation of the cost-efficient algorithm runs far cheaper than all base line algorithms. When you run all these algorithms against each other, the cost-efficient algorithm comes in at about 50% cheaper. While also considering the average waiting time, average execution time, and average completion time, the cost-efficient algorithm doesn’t compare to a lot of the configuration files and considering the price reduction this is totally fair. Please refer below to a total visual comparison between algorithms and configuration files 1 through 7.

### Conclusion:

After checking all the comparisons between all the configuration files for all the algorithms, it’s clear that as a baseline cost efficient algorithm the results speak for themselves as there is a cost performance cut of about 50% total for all configuration files, while some particular configuration files cuts up to 70% in total costs expended. For a new platform or start up these numbers are extremely beneficial as if the appropriate entity did not have the capital to use on renting servers and also the steep costs of running, they wouldn’t be able to continue running their particular service. Luckily through the implementation of this algorithm, the previously mentioned entity would not have to worry about wasting an enormous sum on renting and running servers. I think the best-case long term with the selected algorithms is to run it for cost performance and slowly increase into other algorithms when profit margins are steady, and the entity is not losing a huge chunk of their capital to the servers.

### References:

<https://github.com/upotudrop/COMP3100GP>

### Demo instructions:

1. Extract submission folder
2. Go to submission folder
3. Run `tar -xvf ds-sim.tar`
4. Run `mv ds-server /…/Stage3Submission`, Note path may be different on different machines.
5. Run ‘mv ds-client /…/Stage3Submission`, similarly.
6. To compile code, open the ‘comp3100stage3’ folder
7. And run the commands
8. Javac comp3100stage3/\*.java
9. Java comp3100stage3/Client -a [CEA] while the server is running
10. You will see three tests scripts, testsff, testswf and testsbf.
11. Test client program by running `./tests[algorithm].sh Client.class -a [algorithm] -n`
12. These test scripts are for the user to compare against the new algorithm.