

ECE 6101 Course Project

Distributed Batch Processing System - Option 1

Abhishek Jain
ajain333@gatech.edu

Akar Shah
akar.j.shah@gatech.edu

Experiment Screenshots

Experiment to test non-blocking request handling:

Note: For all experiments, the sleep duration for each task of the *Hello* Job was changed from 1sec to 5secs and for the *Mvm* Job, the sleep duration for each task was changed from 0sec to 1sec. New job files were also created for different experiments such as *Hello8* (8 tasks), *Hello3* (3 tasks), *Hello2* (2 tasks). The only difference between these jobs is the number of tasks in each job.

Part A: Simultaneous registration of multiple workers

To carry out this test, 2 jobs were assigned to the scheduler with no workers initially. Then, one by one 2 workers were added and the jobs were allowed to progress and complete. Initially both jobs start working with the first worker that was added. Upon adding a second worker, the remaining tasks of the jobs were distributed among the workers. This has been shown as follows:

```
marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar 51000
Worker 0 localhost 51001 created
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello8
job submitted
job started
task 0 finished on worker 0
task 1 finished on worker 0
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello8
job submitted
job started
task 0 finished on worker 0
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51001
This is worker 0
task0: Hello World
task0: Hello World
task1: Hello World
task1: Hello World
[]

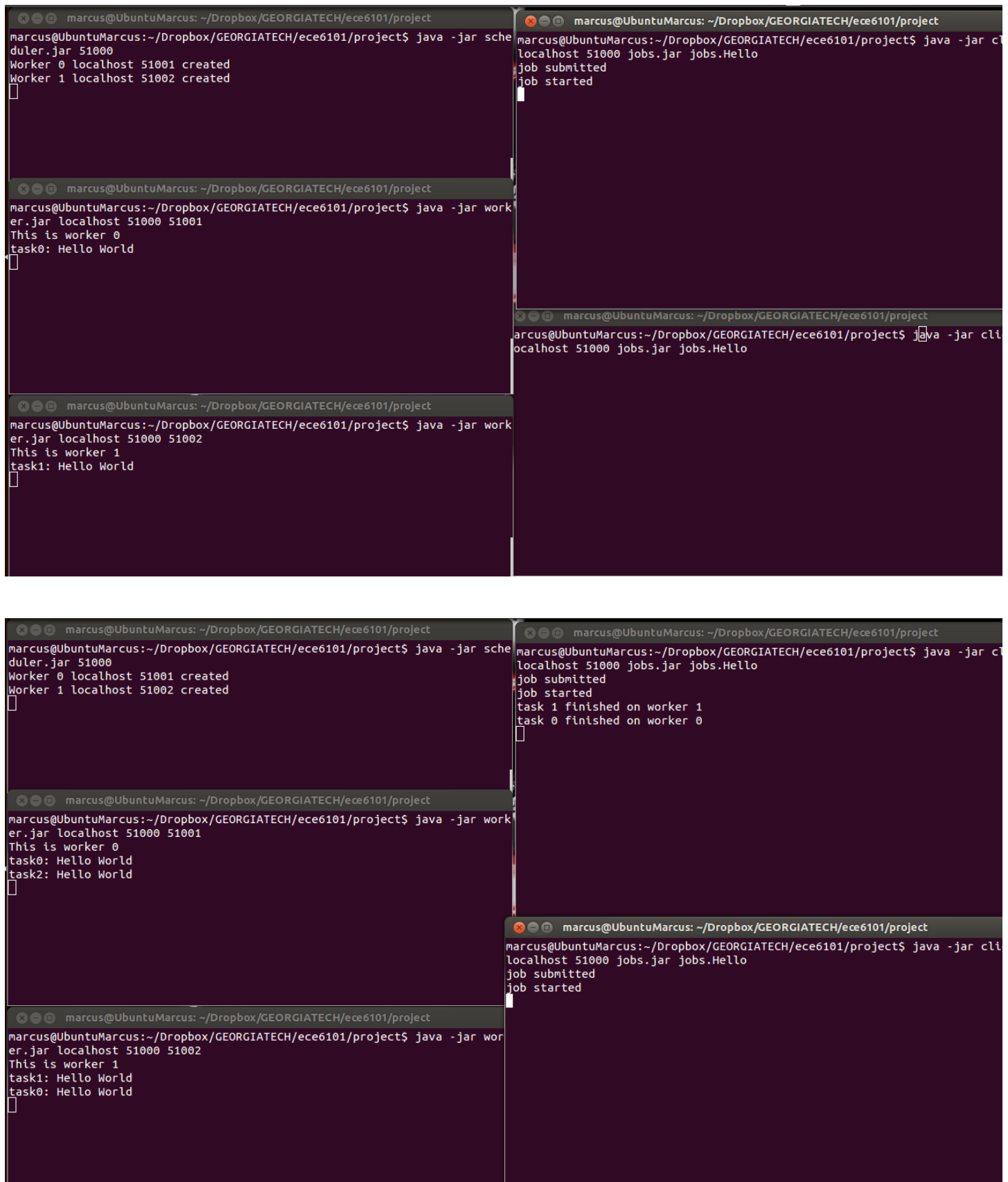
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51002
[]
```

<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar scheduler.jar 51000 Worker 0 localhost 51001 created Worker 1 localhost 51002 created [] marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project task0: Hello World task1: Hello World task1: Hello World task2: Hello World task2: Hello World task3: Hello World task3: Hello World task4: Hello World task5: Hello World task6: Hello World marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar worker.jar localhost 51000 51002 this is worker 1 task4: Hello World task5: Hello World task6: Hello World</pre>	<pre>marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello8 job submitted job started task 0 finished on worker 0 task 1 finished on worker 0 task 2 finished on worker 0 task 3 finished on worker 0 task 4 finished on worker 0 task 5 finished on worker 0 []</pre>	<pre>marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello8 job submitted job started task 0 finished on worker 0 task 1 finished on worker 0 task 2 finished on worker 0 task 3 finished on worker 0 task 4 finished on worker 1 task 5 finished on worker 1 []</pre>
--	--	--

<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar scheduler.jar 51000 Worker 0 localhost 51001 created Worker 1 localhost 51002 created [] marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project task1: Hello World task1: Hello World task2: Hello World task2: Hello World task3: Hello World task3: Hello World task4: Hello World task5: Hello World task6: Hello World task7: Hello World marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar worker.jar localhost 51000 51002 this is worker 1 task4: Hello World task5: Hello World task6: Hello World task7: Hello World</pre>	<pre>marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello8 job submitted job started task 0 finished on worker 0 task 1 finished on worker 0 task 2 finished on worker 0 task 3 finished on worker 0 task 4 finished on worker 0 task 5 finished on worker 0 task 6 finished on worker 0 task 7 finished on worker 0 job finished jobId=1 arrivalTime=19132334 waitTime=3484 execTime=59991 marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ []</pre>	<pre>marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello8 job submitted job started task 0 finished on worker 0 task 1 finished on worker 0 task 2 finished on worker 0 task 3 finished on worker 0 task 4 finished on worker 1 task 5 finished on worker 1 task 6 finished on worker 1 task 7 finished on worker 1 job finished jobId=2 arrivalTime=19132889 waitTime=7933 execTime=56003 marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ []</pre>
---	--	--

Part B: Simultaneous job submission

To carry out this test, 2 workers were initially asked to carry out a single job. During the execution of the first job, another job was added which was then handled by both the existing workers. This is shown below:



The image displays four terminal windows arranged in a 2x2 grid, showing the execution of a job submission and worker tasks. The terminal windows are titled 'marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project'.

Top Left Terminal:

```
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar 51000
Worker 0 localhost 51001 created
Worker 1 localhost 51002 created
```

Top Right Terminal:

```
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
```

Bottom Left Terminal:

```
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51001
This is worker 0
task0: Hello World
```

Bottom Right Terminal:

```
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51002
This is worker 1
task1: Hello World
```

The bottom row of screenshots shows the continuation of the job execution. The left terminal shows the worker 0 output for task 2 and task 0, and the right terminal shows the worker 1 output for task 1 and task 0, indicating that both workers have completed their assigned tasks.

```
marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar 51000
Worker 0 localhost 51001 created
Worker 1 localhost 51002 created
[]

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51001
This is worker 0
task0: Hello World
task2: Hello World
task3: Hello World
[]

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51002
This is worker 1
task1: Hello World
task0: Hello World
task1: Hello World
[]

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 1 finished on worker 1
task 0 finished on worker 0
task 2 finished on worker 0
[]

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 1
[]
```

```
marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar 51000
Worker 0 localhost 51001 created
Worker 1 localhost 51002 created
[]

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51001
This is worker 0
task0: Hello World
task2: Hello World
task3: Hello World
task3: Hello World
[]

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51002
This is worker 1
task1: Hello World
task0: Hello World
task1: Hello World
task2: Hello World
[]

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 1 finished on worker 1
task 0 finished on worker 0
task 2 finished on worker 0
task 3 finished on worker 0
job finished
jobId=1 arrivalTime=1512829 waitTime=58 execTime=14966
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ []

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 1
task 1 finished on worker 1
[]
```

```
marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar 51000
Worker 0 localhost 51001 created
Worker 1 localhost 51002 created

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51001
This is worker 0
task0: Hello World
task2: Hello World
task3: Hello World
task3: Hello World

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51002
This is worker 1
task1: Hello World
task0: Hello World
task1: Hello World
task2: Hello World

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 1 finished on worker 1
task 0 finished on worker 0
task 2 finished on worker 0
task 3 finished on worker 0
job finished
jobId=1 arrivalTime=1512829 waitTime=58 execTime=14966
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 1
task 1 finished on worker 1
task 2 finished on worker 1
task 3 finished on worker 0
job finished
jobId=2 arrivalTime=1515976 waitTime=1910 execTime=14969
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$
```

Experiment to test fair scheduling:

Case 1: 1 worker and number of jobs is greater than 1

```
marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar 51000
Worker 0 localhost 51001 created

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51001
This is worker 0
task0: Hello World
task0: Hello World
task0: Hello World
task1: Hello World
task1: Hello World
task1: Hello World
task2: Hello World
task2: Hello World
task2: Hello World
task3: Hello World
task3: Hello World
task3: Hello World

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 0
task 1 finished on worker 0
task 2 finished on worker 0
task 3 finished on worker 0
job finished
jobId=1 arrivalTime=46758080 waitTime=57 execTime=64995
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 0
task 1 finished on worker 0
task 2 finished on worker 0
task 3 finished on worker 0
job finished
jobId=4 arrivalTime=46759564 waitTime=13581 execTime=64994
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 0
task 1 finished on worker 0
task 2 finished on worker 0
task 3 finished on worker 0
job finished
jobId=2 arrivalTime=46758473 waitTime=4664 execTime=64997
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 0
task 1 finished on worker 0
task 2 finished on worker 0
task 3 finished on worker 0
job finished
jobId=3 arrivalTime=46759008 waitTime=13581 execTime=64994
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$
```

Case 2: Number of workers is less than the number of tasks

```
marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
duler.jar 51000
Worker 0 localhost 51001 created
Worker 1 localhost 51002 created
Worker 2 localhost 51003 created
Worker 3 localhost 51005 created
Worker 4 localhost 51001 created

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
task0: Hello World
task3: Hello World
task1: Hello World
task2: Hello World
task3: Hello World

marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar work
er.jar localhost 51000 51002
This is worker 1
task0: Hello World
task1: Hello World

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$
task2: Hello World
task1: Hello World
task0: Hello World
task1: Hello World
task2: Hello World
task3: Hello World

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
task2: Hello World
task3: Hello World
task2: Hello World
task0: Hello World
task1: Hello World
task2: Hello World
task3: Hello World

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
job submitted
job started
task 0 finished on worker 4
task 2 finished on worker 3
task 1 finished on worker 2
task 3 finished on worker 4
job finished
jobId=8 arrivalTime=8417654 waitTime=44 execTime=14965
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
job submitted
job started
task 0 finished on worker 4
task 1 finished on worker 3
task 2 finished on worker 3
task 3 finished on worker 3
job finished
jobId=9 arrivalTime=8418010 waitTime=4688 execTime=19980
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
job submitted
job started
task 0 finished on worker 3
task 1 finished on worker 2
task 2 finished on worker 2
task 3 finished on worker 2
job finished
jobId=10 arrivalTime=8418573 waitTime=4129 execTime=19981
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
job started
task 0 finished on worker 2
task 1 finished on worker 4
task 2 finished on worker 4
task 3 finished on worker 4
job finished
jobId=11 arrivalTime=8419080 waitTime=3620 execTime=24969
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$
```

Experiment to test fault tolerance:

The following experiment shows how our system exhibits fault tolerance:

Initially there are no workers but the jobs are still submitted and wait for any free worker to register itself.

```
marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar sche
duler.jar 51000

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar cl
localhost 51000 jobs.jar jobs.Hello
job submitted

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar clt
localhost 51000 jobs.jar jobs.Hello
job submitted

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar cl
ient.jar localhost 51000 jobs.jar jobs.Hello
job submitted
```

Here we see that as workers are added, tasks from different jobs are distributed fairly between the workers and execution of different jobs starts.

<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar scheduler.jar 51000 Worker 0 localhost 51001 created Worker 1 localhost 51002 created Worker 2 localhost 51003 created </pre>	<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello job submitted job started </pre>
<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar worker.jar localhost 51000 51001 This is worker 0 task0: Hello World </pre>	<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello job submitted job started </pre>
<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar worker.jar localhost 51000 51002 This is worker 1 task0: Hello World </pre>	
<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar worker.jar localhost 51000 51003 This is worker 2 task0: Hello World </pre>	<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello job submitted job started </pre>

<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar scheduler.jar 51000 Worker 0 localhost 51001 created Worker 1 localhost 51002 created Worker 2 localhost 51003 created </pre>	<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello job submitted job started task 0 finished on worker 0 </pre>
<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar worker.jar localhost 51000 51001 This is worker 0 task0: Hello World task1: Hello World </pre>	<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello job submitted job started task 0 finished on worker 1 </pre>
<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar worker.jar localhost 51000 51002 This is worker 1 task0: Hello World task1: Hello World </pre>	
<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar worker.jar localhost 51000 51003 This is worker 2 task0: Hello World task1: Hello World </pre>	<pre>marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project\$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello job submitted job started task 0 finished on worker 2 </pre>

```
marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar 51000
Worker 0 localhost 51001 created
Worker 1 localhost 51002 created
Worker 2 localhost 51003 created
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51001
This is worker 0
task0: Hello World
task1: Hello World
task2: Hello World
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51002
This is worker 1
task0: Hello World
task1: Hello World
task2: Hello World
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51003
This is worker 2
task0: Hello World
task1: Hello World
task2: Hello World
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 0
task 1 finished on worker 0

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 1
task 1 finished on worker 1

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 2
task 1 finished on worker 2
```

The diagrams below shows worker 2 failing and then shows how the remaining active workers namely worker 1 and 0 manage the remainder of the tasks from different jobs. Here worker 2 fails.

```
marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar 51000
Worker 0 localhost 51001 created
Worker 1 localhost 51002 created
Worker 2 localhost 51003 created
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51001
This is worker 0
task0: Hello World
task1: Hello World
task2: Hello World
task3: Hello World
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51002
This is worker 1
task0: Hello World
task1: Hello World
task2: Hello World
task3: Hello World
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51003
This is worker 2
task0: Hello World
task1: Hello World
task2: Hello World
^Cmarcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 0
task 1 finished on worker 0
task 2 finished on worker 0

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 1
task 1 finished on worker 1
task 2 finished on worker 1

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 2
task 1 finished on worker 2
task 2 finished on worker 0
```


Here the remaining workers handle the remaining tasks and jobs.

```
marcus@UbuntuMarcus: ~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar 51000
Worker 0 localhost 51001 created
Worker 1 localhost 51002 created
Worker 2 localhost 51003 created
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51001
This is worker 0
task0: Hello World
task1: Hello World
task2: Hello World
task2: Hello World
task3: Hello World
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
This is worker 1
task0: Hello World
task1: Hello World
task2: Hello World
task3: Hello World
task3: Hello World
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51003
This is worker 2
task0: Hello World
task1: Hello World
task2: Hello World
^Cmarcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 0
task 1 finished on worker 0
task 2 finished on worker 0
task 3 finished on worker 1
job finished
jobId=1 arrivalTime=3907162 waitTime=51232 execTime=21013
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 1
task 1 finished on worker 1
task 2 finished on worker 1
task 3 finished on worker 0
job finished
jobId=2 arrivalTime=3911109 waitTime=48326 execTime=23934
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar client.jar localhost 51000 jobs.jar jobs.Hello
job submitted
job started
task 0 finished on worker 2
task 1 finished on worker 2
task 2 finished on worker 0
task 3 finished on worker 1
job finished
jobId=3 arrivalTime=3913884 waitTime=46721 execTime=23803
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$
```

As can be seen from the above experiments, it is seen that our system continues to execute jobs even after there is worker failure. Repeated testing with different numbers of node failures still yields the same results and as long as there is even a single worker alive, jobs will continue to get executed, irrespective of the complexity , duration or the number of tasks of the job.

The diagram below shows the result of an execution where several jobs are given to the scheduler and not only are several workers made to fail during the runtime of the jobs, several new workers are also added during the runtime of different jobs. Thus it can be seen that no matter what the scenario, our system is able to complete all jobs that are assigned to it.

```
Worker 2 localhost 51003 created
Worker 3 localhost 51004 created
Worker 4 localhost 51006 created
Worker 5 localhost 51007 created
Worker 6 localhost 51009 created
Worker 7 localhost 51008 created

task0: Hello World
task1: Hello World
task2: Hello World
task3: Hello World
task7: Hello World

This is worker 1
task0: Hello World
task1: Hello World
task2: Hello World
task3: Hello World

jar worker.jar localhost 51000 51003
This is worker 2
task0: Hello World
task1: Hello World
marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

00 51004
This is worker 3
task0: Hello World
task1: Hello World
task2: Hello World
task4: Hello World

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar localhost 51000 51008
This is worker 7
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51006
This is worker 4
task1: Hello World
task5: Hello World
^Cmarcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51007
This is worker 5
task6: Hello World
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar worker.jar localhost 51000 51009
This is worker 6
[]

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar localhost 51000 jobs.Hello
job submitted
job started
task 0 finished on worker 0
task 1 finished on worker 0
task 2 finished on worker 0
task 3 finished on worker 0
task 4 finished on worker 0
task 5 finished on worker 0
task 6 finished on worker 5
task 7 finished on worker 0
job finished
jobId=2 arrivalTime=18225502 waitTime=15042 execTime=21347

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar localhost 51000 jobs.Hello2
job submitted
job started
task 0 finished on worker 3
task 1 finished on worker 4
job finished

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$ java -jar scheduler.jar localhost 51000 jobs.Hello3
job submitted
job started
task 0 finished on worker 1
task 1 finished on worker 3
task 2 finished on worker 1
job finished

marcus@UbuntuMarcus:~/Dropbox/GEORGIA TECH/ece6101/project$
```