PROGRAMMING ASSIGNMRNT 3 REPORT

Kunal Dhande

INDEX

Design

- Local Client-Worker Experiment
- Remote Client-Worker Experiment

Installation Manual

- Installation Prerequisites
- Run instructions

Performance Evaluation

- Local Client-Worker Experiment
- Remote Client-Worker Experiment

Animoto Clone

Design

In this experiment, we are building a cloud-con clone, a distributed task execution framework that has two components - a client (command line tool which submits tasks to Amazon SQS to local queue) and worker (command line tool which retrieve task from SQS or local queue and execute it). There can be multiple client and multiple workers. In this experiment, we are using SQS, Amazon's Queueing service to handle remote executions.

We are running scaling experiments for throughput and efficiency.

The throughput is calculated as:

$$Throughput = \frac{No\ of\ tasks}{Total\ time\ taken\ to\ execute\ tasks}$$

The efficiency of the system is calculated as follows:

$$Efficiency = \frac{Ideal\ time\ to\ complete\ tasks}{Actual\ time\ to\ complete\ tasks}$$

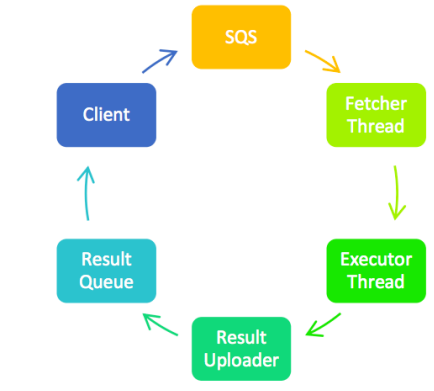
To run this experiment t2.micro instance is used.

Local Client-Worker Experiment

In local client-worker experiment, distributed execution framework is modeled on a single machine and tasks are shared using in-memory Queue. This should be the fastest way of sharing tasks within single process. To find the scalability of the setup, number of threads are varied from 1, 2, 4, 8 and 16.

In this experiment, client and worker runs within same process.

- Program accepts workload file and number of threads as command line arguments.
- Once programs receive file name, it starts reading file and pushes number of task to in-memory queue.
- After completing this, program one-by-one pop each task and execute it and stores result in into an external file.
- These tasks are executed in number of threads specified by user.



Life Cycle of Remote Client-Worker

Remote Client-Worker Experiment

In remote client-worker experiment, distributed execution framework is modeled on number of machines and tasks are shared using SQS. This experiment has two different components – client and worker. Unlike, local client-worker, they work independently. To find the scalability of the setup, number of node/ machines are varied from 1, 2, 4, 8 and 16.

Client:

- Client reads workload file and pushes each task to SQS with some queue-name.
- Then, messge_id from SQS is being stored in Dynamo DB to avoid execution of duplicate task. (SQS guarantees that it will not lose any task, but does not guarantee that it will not repeat task again)

Worker:

- Worker has the same queue-name in which client had pushed task.
- Worker always checks for the new task in SQS as soon as new task added to SQS, worker starts polling them.
- Then, worker check the same task is being executed or not by using Dynamo DB. As soon as task completes, worker deletes the task id from dynamo DB.

Installation Manual

Here all the steps are mentioned to be followed. All the commands below are run from the scripts folder.

Installation Prerequisites

1. ### Parallel-ssh

```
sudo apt-get install pssh
```

2. ### Ruby (v 2.0 and above)

To install Ruby on Ubuntu run the script in executables folder named ruby-setup.sh. This will install all necessary software packages needed to run cloud-con clone.

```
./ruby-setup.sh
```

3. ### Install ffmpeg

Run following command in terminal to install ffmpeg (For animoto clone)

```
sudo add-apt-repository ppa:kirillshkrogalev/ffmpeg-next
sudo apt-get update
sudo apt-get install ffmpeg
```

4. ### Assess key for AWS

Get AWS credentials from AWS web interface under menu Credentials and change it in each client and worker files present in executable folder.

Run instructions

1. ### Local Client-Worker Experiment:

To run cloud-con locally execute

```
client –s LOCAL -t N -w <WORKLOAD_FILE>
```

LOCAL : Queue name indicates that client will run locally
N : Number of worker/ threads to run
WORKLOAD_FILE : File with number of operations to execute

2. ### Remote Client-Worker Experiment:

In this experiment, we have to run client and worker separately. In this experiment worker is considered as node. This experiment has to be run on 1, 2, 4 , 8 and 16 nodes.

To run client:

client –s QNAME -w <WORKLOAD_FILE>

QNAME : Queue name for SQS

To run worker:

```
worker –s QNAME –t N
```

You can run number of worker parallel with pssh

```
parallel-ssh -i -v -t 0 -p <NO_OF_WORKERS> -l ubuntu -h hosts
             -x "-t -t -oStrictHostKeyChecking=no" 'source
             /home/ubuntu/.bash_profile; ruby worker < QNAME > 1'
```

Performance Evaluation

Local Client-Worker Experiment

1. Workload file with 100000 Sleep 0 second tasks

Type of worker	Workers	Threads	Total tasks	Time taken (sec)	Ideal Time (sec)	Efficiency (%)	Throughput (task/sec)
LOCAL	1	1	100000	58.11064649	0	0	1720.855059
LOCAL	1	2	100000	44.2324121	0	0	2260.785593
LOCAL	1	4	100000	43.92974377	0	0	2276.362014
LOCAL	1	8	100000	44.48091555	0	0	2248.155164
LOCAL	1	16	100000	44.1926558	0	0	2262.819425

2. Workload file with 10000 Sleep 10 ms tasks

Type of worker	Workers	Threads	Total tasks	Time taken (sec)	Ideal Time (sec)	Efficiency (%)	Throughput (task/sec)
LOCAL	1	1	10000	107.1493869	100	93.32764555	93.32764555
LOCAL	1	2	10000	53.79144645	50	92.95158116	185.9031623
LOCAL	1	4	10000	27.09604931	25	92.26437299	369.057492
LOCAL	1	8	10000	13.47669554	12.5	92.75270755	742.0216604
LOCAL	1	16	10000	6.700074911	6.25	93.28253912	1492.520626

3. Workload file with 100 Sleep 1 second tasks

Type of worker	Workers	Threads	Total tasks	Time taken (sec)	Ideal Time (sec)	Efficiency (%)	Throughput (task/sec)
LOCAL	1	1	100	100.0848587	100	99.91521329	0.999152133
LOCAL	1	2	100	50.04937458	50	99.90134826	1.998026965
LOCAL	1	4	100	25.02543879	25	99.89834829	3.995933932
LOCAL	1	8	100	13.01436567	12.5	96.04770846	7.683816677
LOCAL	1	16	100	7.009860516	6.25	89.16011932	14.26561909

4. Workload file with 10 Sleep 10 seconds tasks

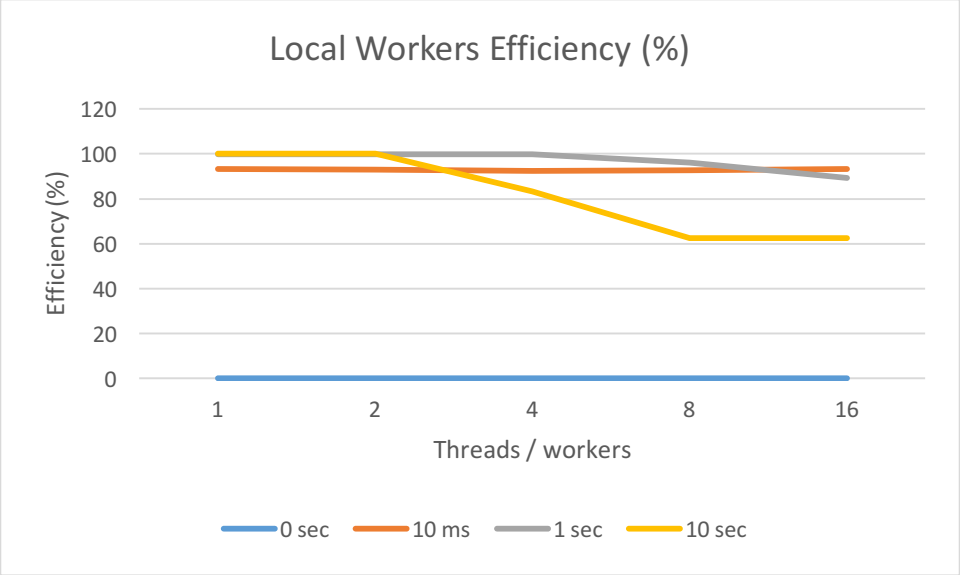
Type of worker	Workers	Threads	Total tasks	Time taken (sec)	Ideal Time (sec)	Efficiency (%)	Throughput (task/sec)
LOCAL	1	1	10	100.0084007	100	99.99160003	0.0999916
LOCAL	1	2	10	50.00522733	50	99.98954644	0.199979093
LOCAL	1	4	10	30.00370336	25	83.3230475	0.33329219
LOCAL	1	8	10	20.00264573	12.5	62.49173318	0.499933865
LOCAL	1	16	10	10.00642538	6.25	62.45986716	0.999357875

Efficiency:

Threads \ Time	0 sec	10 ms	1 sec	10 sec
1	0	93.32764555	99.91521329	99.99160003
2	0	92.95158116	99.90134826	99.98954644
4	0	92.26437299	99.89834829	83.3230475
8	0	92.75270755	96.04770846	62.49173318
16	0	93.28253912	89.16011932	62.45986716

It is observed that efficiency is reducing as increase in number of threads / workers. This is expected as t2.micro instance has only one core and it is spending more time in thread scheduling. Thus, more threads result into more time in scheduling than computing.

Here, task with 10sec sleeping time with single worker thread has highest efficiency.

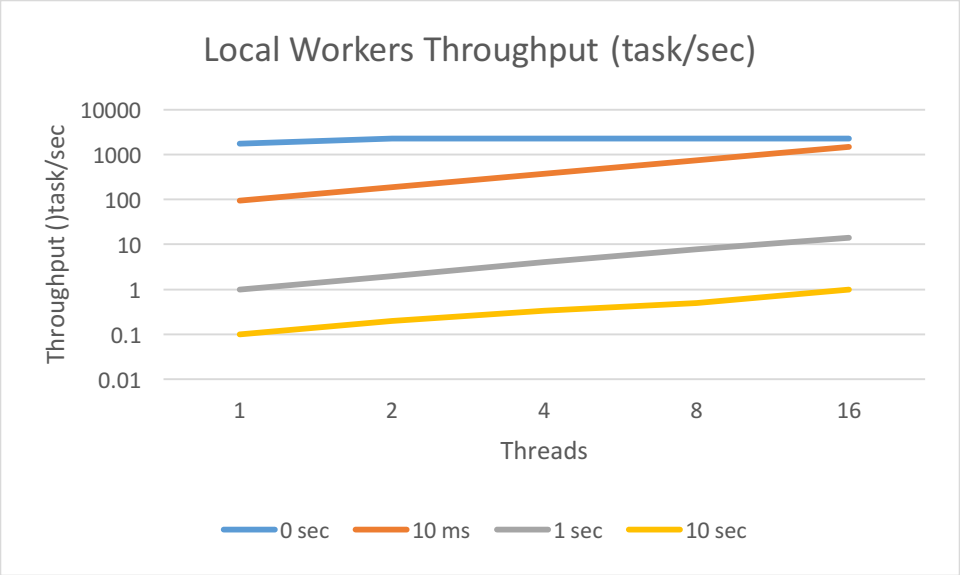


Throughput:

Threads \ Time	0 sec	10 ms	1 sec	10 sec
1	1720.855059	93.32764555	0.999152133	0.0999916
2	2260.785593	185.9031623	1.998026965	0.199979093
4	2276.362014	369.057492	3.995933932	0.33329219
8	2248.155164	742.0216604	7.683816677	0.499933865
16	2262.819425	1492.520626	14.26561909	0.999357875

It is observed that the throughput is increasing with increase in the number of workers. This is expected as there will be more number of threads to do the job with increase in number of threads resulting in comparatively more work done in same time.

Here, task with 0 sec has highest throughput followed by 10 ms task.


Local Workers Throughput (task/sec)
Throughput ()task/sec
10000
1000
100
10
1
0.1
0.01
1
2
4
8
16
Threads
0 sec
10 ms
1 sec
10 sec

Remote Client-Worker Experiment

1. Workload file with 100000 Sleep 0 second tasks

Type of worker	Workers	Threads	Total tasks	Time taken (sec)	Ideal Time (sec)	Efficiency (%)	Throughput (task/sec)
REMOTE	1	1	100000	14321.97076	0	0	6.9822793
REMOTE	1	2	100000	8104.540102	0	0	12.33876306
REMOTE	1	4	100000	4847.563846	0	0	20.6289186
REMOTE	1	8	100000	1960.570333	0	0	51.00556624
REMOTE	1	16	100000	1032.151345	0	0	96.88501644

2. Workload file with 10000 Sleep 10ms tasks

Type of worker	Workers	Threads	Total tasks	Time taken (sec)	Ideal Time (sec)	Efficiency (%)	Throughput (task/sec)
REMOTE	1	1	10000	2269.848737	100	4.405579912	4.405579912
REMOTE	1	2	10000	1006.454642	50	4.967933765	9.935867529
REMOTE	1	4	10000	452.8329048	25	5.52080022	22.08320088
REMOTE	1	8	10000	249.4162654	12.5	5.011702016	40.09361612
REMOTE	1	16	10000	137.4333827	6.25	4.547657838	72.7625254

3. Workload file with 100 Sleep 1 second tasks

Type of worker	Workers	Threads	Total tasks	Time taken (sec)	Ideal Time (sec)	Efficiency (%)	Throughput (task/sec)
REMOTE	1	1	100	134.3876686	100	74.41158927	0.744115893
REMOTE	1	2	100	78.09346628	50	64.02584285	1.280516857
REMOTE	1	4	100	50.102157	25	49.8980513	1.995922052
REMOTE	1	8	100	24.89731884	12.5	50.20620927	4.016496742
REMOTE	1	16	100	21.62124918	6.25	28.90674793	4.625079668

4. Workload file with 10 Sleep 10 seconds tasks

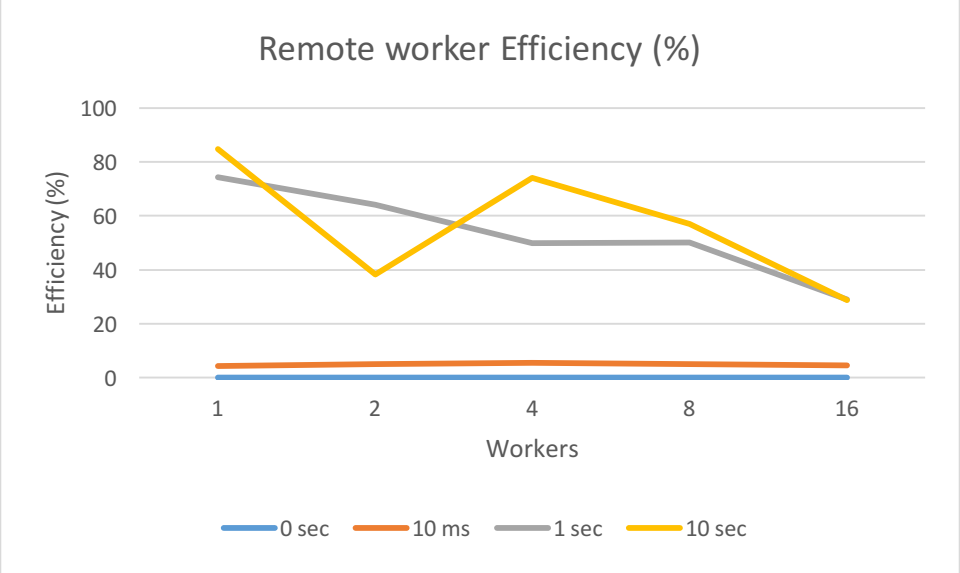
Type of worker	Workers	Threads	Total tasks	Time taken (sec)	Ideal Time (sec)	Efficiency (%)	Throughput (task/sec)
REMOTE	1	1	10	117.8522172	100	84.85203111	0.084852031
REMOTE	1	2	10	130.6565192	50	38.26827801	0.076536556
REMOTE	1	4	10	33.78493875	25	73.99747024	0.295989881
REMOTE	1	8	10	21.96062392	12.5	56.92005858	0.455360469
REMOTE	1	16	10	21.79043339	6.25	28.68231158	0.458916985

Efficiency:

Threads \ Time	0 sec	10 ms	1 sec	10 sec
1	0	4.405579912	74.41158927	84.85203111
2	0	4.967933765	64.02584285	38.26827801
4	0	5.52080022	49.8980513	73.99747024
8	0	5.011702016	50.20620927	56.92005858
16	0	4.547657838	28.90674793	28.68231158

It is observed that the efficiency of the system is not consistent for the task with high sleep time whereas task with sleep time 0 sec and 10ms is consistent, but too low. On other hand, we can say that that increasing number of workers results into reducing efficiency. This might be because of scheduling overhead. E.g., "Sleep 10 ms" is sleeping for same amount of time as 10 secs, but the number of network connections to get tasks are more in case of 10ms. So, it results into low efficiency.

Here, task with 10sec sleeping time with single worker thread has highest efficiency.

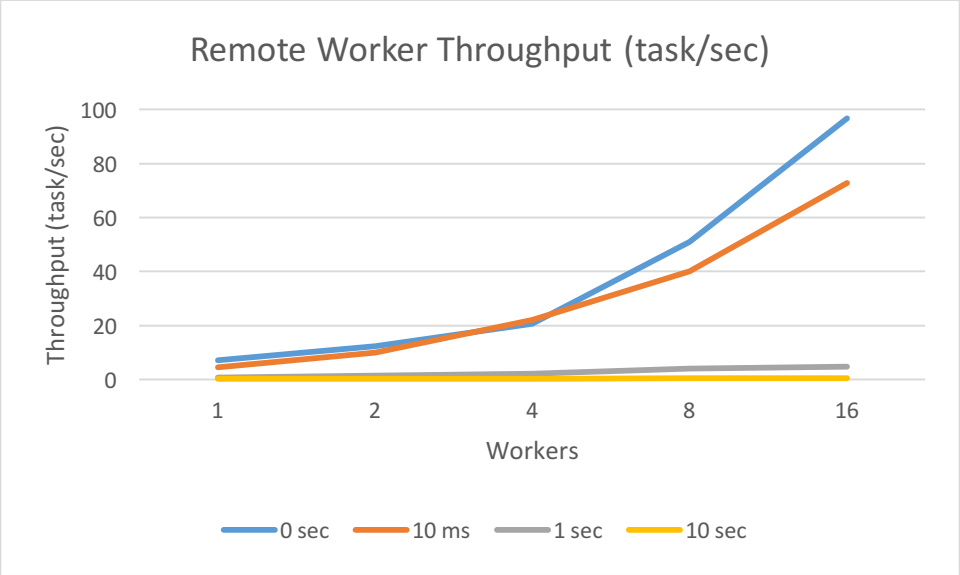


Throughput:

Threads \ Time	0 sec	10 ms	1 sec	10 sec
1	6.9822793	4.405579912	0.744115893	0.084852031
2	12.33876306	9.935867529	1.280516857	0.076536556
4	20.6289186	22.08320088	1.995922052	0.295989881
8	51.00556624	40.09361612	4.016496742	0.455360469
16	96.88501644	72.7625254	4.625079668	0.458916985

In this experiment, number shows that increase in number of workers ultimately give high throughput as well. This is oblivious as the increase in number of worker would give more computing power than less number of workers

Here, task with 0 sec has highest throughput followed by 10 ms task.



Animoto Clone

To run animoto clone t2.micro instance is used.

1. *Design*

Animoto uses the same design as remote client and server. But, as the functionality is changed, client and worker code is modified according to requirement.

Client:

- In remote client, client used to read and consider each line in file as different task. In this case, client read full file. File has number of image links.
- Client joins these links separated by comma, and then push it to SQS.

Worker:

- Worker also has similar functionality. Instead of just executing the task in SQS, worker split message retrieved from SQS by comma and download images in temp directory for further processing
- After downloading images, worker execute command (ffmpeg – video processing library) to create video from these images.
- Once video generated, worker, save that video to S3 (Simple Storage Service), cloud storage by AWS.

Animoto clone generally takes 3-3.5 minutes to generate video and store it to S3.

2. *Run Instructions*

To run animoto client just enter this command in terminal. This will push all video creation operations to SQS.

client –s animoto -w <WORKLOAD_FILE>

QNAME : animoto.

And to run worker,

worker –s animoto –t N N: number of threads

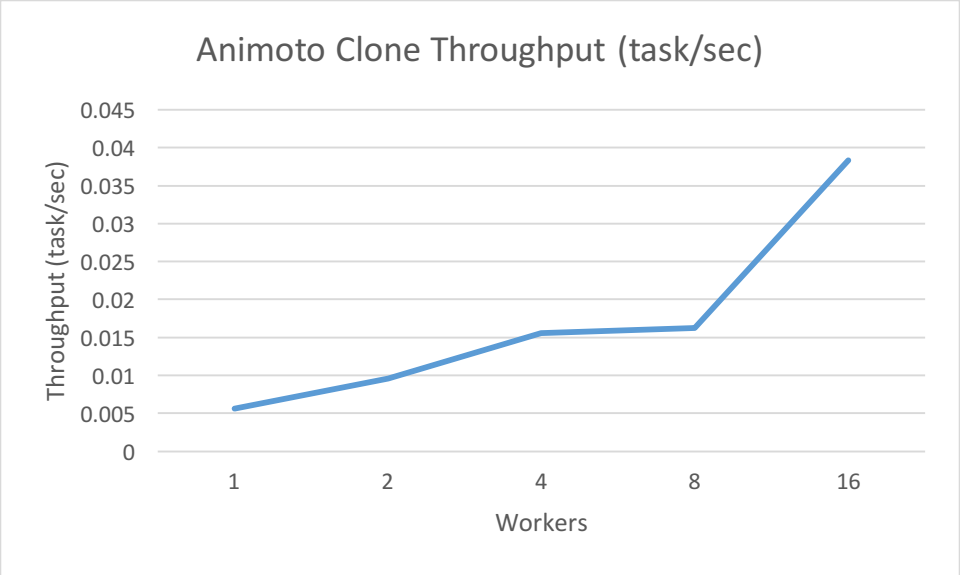
You can run number of worker parallel with pssh

```
parallel-ssh -i -v -t 0 -p <NO_OF_WORKERS> -l ubuntu -h hosts
             -x "-t -t -oStrictHostKeyChecking=no" 'source
             /home/ubuntu/.bash_profile; ruby worker < QNAME > 1'
```

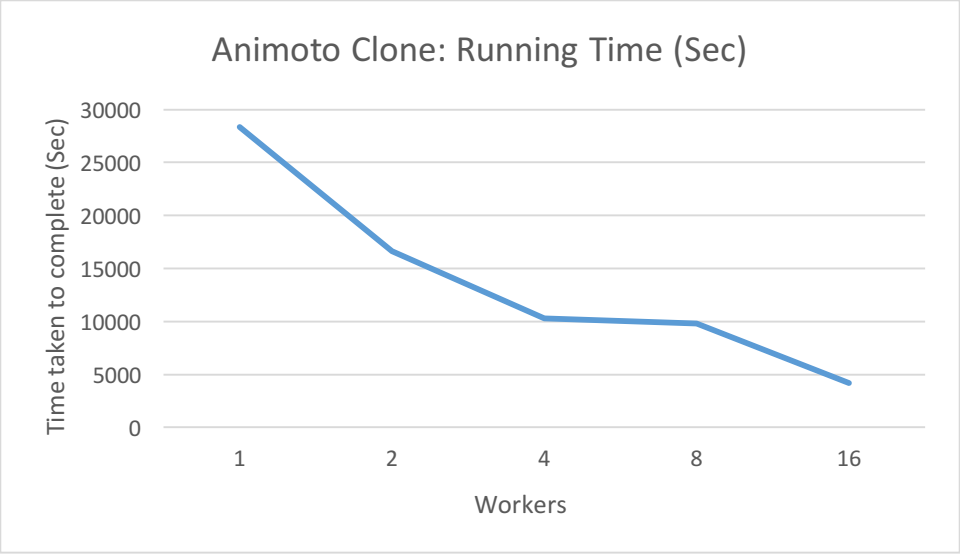
3. *Results*

Workers	Time taken (sec)	Throughput (task/sec)
1	28355.73217	0.005642598
2	16643.36921	0.009613438
4	10295.00625	0.015541516
8	9829.142758	0.016278124
16	4170.473698	0.038364946

It is observed that as increase in number of worker, throughput of the system is increasing. This is consistent with our previous experiments.



Animoto clone with 16 workers, completes execution faster than other. Because it has got more computing power and resources. System with 16 workers complete execution almost $1/16^{th}$ time compared to system with single worker.


Animoto Clone: Running Time (Sec)
Time taken to complete (Sec)
30000
25000
20000
15000
10000
5000
0
1
2
4
8
16
Workers