Github URL

https://github.com/Shengnany/cs6650_distributed_systems

Description

Server Design

Package DataAccessLayer:

DBCPDataSource.java: Connection manager class to establish connections between my project and MySQL database.

LiftRideDao.java: DAO class with a record insertion operation.

Package Model:

LiftRide.java: LiftRide POJO
RequestBody.java: A wrapper class for POST request body

Package Servlet:

StatisticsServlet.java: map /skiers/* path
ResortsServlet.java: map /resorts/* path
SkiersServlet.java: map /statistics path

Pub-Consume Design

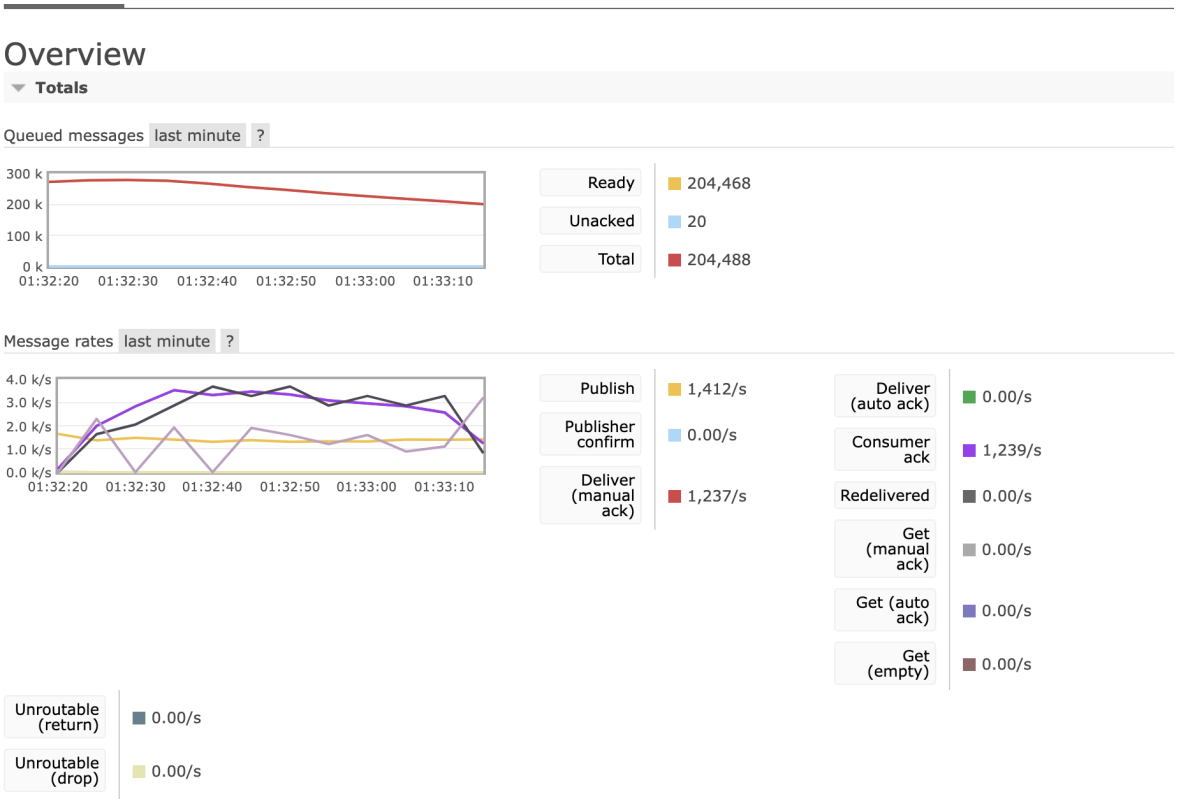
The ThreadedWorker.java receives messages from the queue and puts the record in CopyOnWriteList according to the skierID. The program is multithreaded. 20 Threads are spawned from the program. The key-value pair then is put into ConcurrentHashMap. The LifiRide.java is used to wrap the message consumed from the queue.

Messages are sent using the Client. When running the main() in ClientApp.java, it will issue a post request to the original server/load balancer. Messages are sent using Multiple Work Queues Pattern using the Java Client. It simply distributes tasks among workers. A request is made and encapsulated as a message and sent to a queue. Then many workers will be run in the background and share the tasks and execute them.

I also used a connection pool(BasePooledObjectFactory in apache commons pool2 library) to share a bunch of pre-created channels in the init() method and closed the connection at the end of the request.

One Instance for running 64 threads:

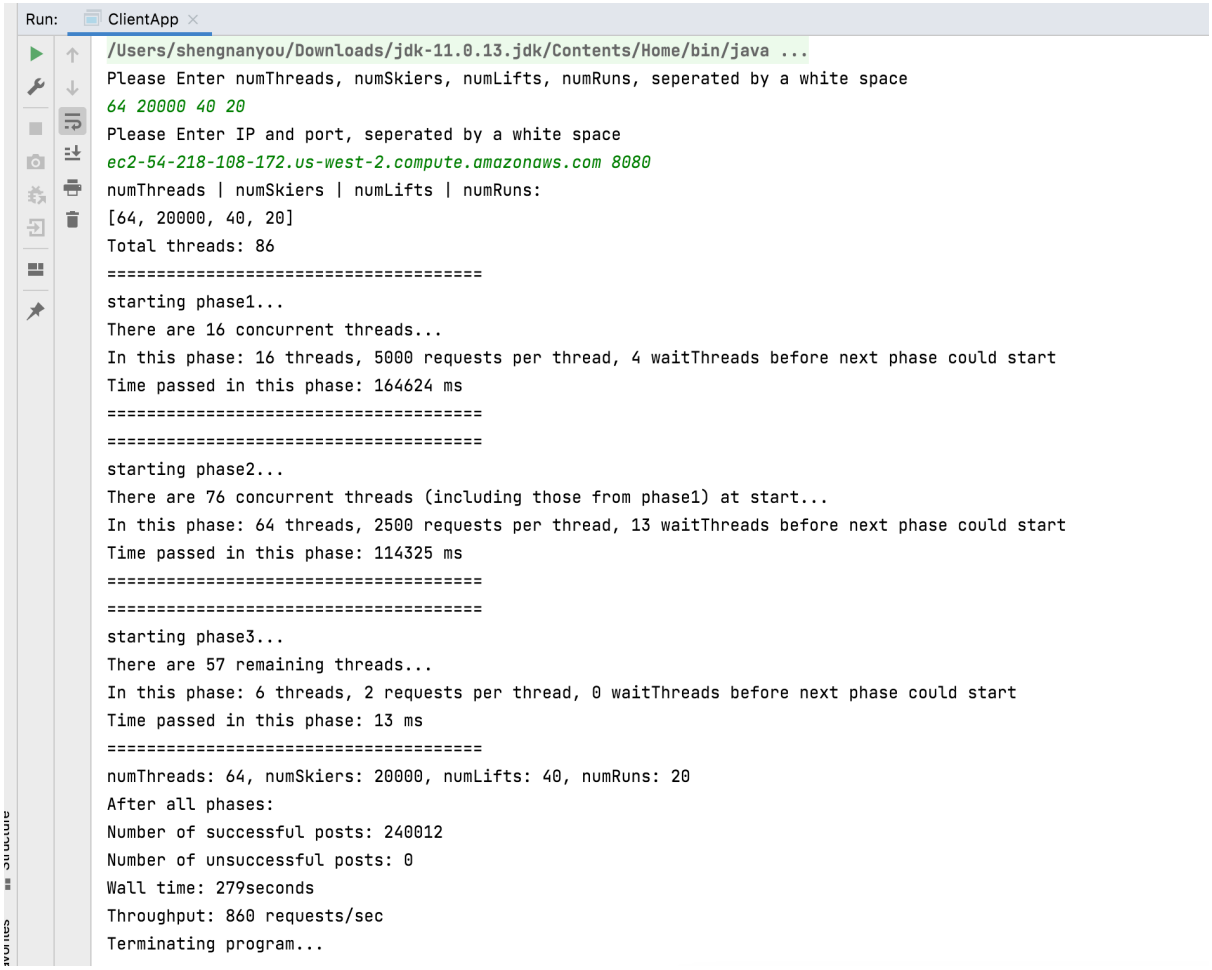
RMQ management window:



Consumer:

```
Callback thread ID = 33 Received '{"resortId":1,"seasonId":2022,"dayId":1,"skier
Id":11607,"time":163,"liftId":19,"waitTime":8}'
Processed {"resortId":1,"seasonId":2022,"dayId":1,"skierId":11607,"time":163,"li
ftId":19,"waitTime":8}
 [x] Received 'LiftRide{skierId=11825, resortId=1, seasonId=2022, dayId=1, time=
217, liftId=26}'
Callback thread ID = 34 Received '{"resortId":1,"seasonId":2022,"dayId":1,"skier
Id":11825,"time":217,"liftId":26,"waitTime":4}'
Processed {"resortId":1,"seasonId":2022,"dayId":1,"skierId":11825,"time":217,"li
ftId":26,"waitTime":4}
 [x] Received 'LiftRide{skierId=14138, resortId=1, seasonId=2022, dayId=1, time=
119, liftId=14}'
Callback thread ID = 33 Received '{"resortId":1,"seasonId":2022,"dayId":1,"skier
Id":14138,"time":119,"liftId":14,"waitTime":9}'
Processed {"resortId":1,"seasonId":2022,"dayId":1,"skierId":14138,"time":119,"li
ftId":14,"waitTime":9}
 [x] Received 'LiftRide{skierId=11595, resortId=1, seasonId=2022, dayId=1, time=
128, liftId=38}'
Callback thread ID = 34 Received '{"resortId":1,"seasonId":2022,"dayId":1,"skier
Id":11595,"time":128,"liftId":38,"waitTime":1}'
Processed {"resortId":1,"seasonId":2022,"dayId":1,"skierId":11595,"time":128,"li
ftId":38,"waitTime":1}
```

Client:



After creating 2 more Instances for running 64 threads:(snapshot in phase2)

After including the load balancer, the throughput also increased.

Connections

All connections (3)

Pagination

Page 1 of 1 - Filter: Regex ?

Displaying 3 items , page size up to: 100

Overview			Details			Network		+/-
Name	**User name**	**State**	**SSL / TLS**	**Protocol**	**Channels**	**From client**	**To client**	
35.85.30.155:57068 ?	user	running	○	AMQP 0-9-1	8	41 kiB/s	7.2 kiB/s	
54.184.16.68:39020 ?	user	running	○	AMQP 0-9-1	20	9.9 kiB/s	87 kiB/s	
54.218.108.172:40302 ?	user	running	○	AMQP 0-9-1	8	41 kiB/s	7.1 kiB/s	

RabbitMQ™ RabbitMQ 3.9.13 Erlang 24.2.2

Refreshed 2022-03-11 01:20:43 Refresh every 5 seconds

Virtual host /

Cluster **rabbit@my-rabb**

User **user** Log

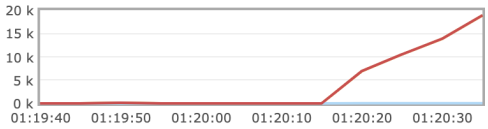
Overview **Connections** **Channels** **Exchanges** **Queues**

Admin

Overview

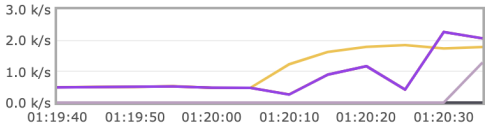
Totals

Queued messages last minute ?



Ready	16,267
Unacked	20
Total	16,287

Message rates last minute ?



Publish	1,786/s
Publisher confirm	0.00/s
Deliver (manual ack)	2,066/s

Deliver (auto ack)	0.00/s
Consumer ack	2,068/s
Redelivered	0.00/s
Get (manual ack)	0.00/s
Get (auto ack)	0.00/s
Get (empty)	0.00/s

Unroutable (return)	0.00/s
Unroutable (drop)	0.00/s

```
Callback thread ID = 33 Received '{"resortId":1,"seasonId":2022,"dayId":1,"skier
Id":6335,"time":244,"liftId":26,"waitTime":2}'
Processed {"resortId":1,"seasonId":2022,"dayId":1,"skierId":6335,"time":244,"lif
tId":26,"waitTime":2}
 [x] Received 'LiftRide{skierId=17319, resortId=1, seasonId=2022, dayId=1, time=
333, liftId=7}'
Callback thread ID = 34 Received '{"resortId":1,"seasonId":2022,"dayId":1,"skier
Id":17319,"time":333,"liftId":7,"waitTime":8}'
Processed {"resortId":1,"seasonId":2022,"dayId":1,"skierId":17319,"time":333,"li
ftId":7,"waitTime":8}
 [x] Received 'LiftRide{skierId=10680, resortId=1, seasonId=2022, dayId=1, time=
115, liftId=28}'
Callback thread ID = 33 Received '{"resortId":1,"seasonId":2022,"dayId":1,"skier
Id":10680,"time":115,"liftId":28,"waitTime":8}'
Processed {"resortId":1,"seasonId":2022,"dayId":1,"skierId":10680,"time":115,"li
ftId":28,"waitTime":8}
 [x] Received 'LiftRide{skierId=17458, resortId=1, seasonId=2022, dayId=1, time=
152, liftId=33}'
Callback thread ID = 34 Received '{"resortId":1,"seasonId":2022,"dayId":1,"skier
Id":17458,"time":152,"liftId":33,"waitTime":9}'
Processed {"resortId":1,"seasonId":2022,"dayId":1,"skierId":17458,"time":152,"li
ftId":33,"waitTime":9}
 [x] Received 'LiftRide{skierId=17388, resortId=1, seasonId=2022, dayId=1, time=
186, liftId=7}'
Callback thread ID = 33 Received '{"resortId":1,"seasonId":2022,"dayId":1,"skier
Id":17388,"time":186,"liftId":7,"waitTime":5}'
Processed {"resortId":1,"seasonId":2022,"dayId":1,"skierId":17388,"time":186,"li
ftId":7,"waitTime":5}
```

```
Please Enter numThreads, numSkiers, numLifts, numRuns, seperated by a white space
64 20000 40 20
Please Enter IP and port, seperated by a white space
lb2-681239996.us-west-2.elb.amazonaws.com 80
numThreads | numSkiers | numLifts | numRuns:
[64, 20000, 40, 20]
Total threads: 86
=====================================
starting phase1...
There are 16 concurrent threads...
In this phase: 16 threads, 5000 requests per thread, 4 waitThreads before next phase could start
Time passed in this phase: 161325 ms
=====================================
=====================================
starting phase2...
There are 76 concurrent threads (including those from phase1) at start...
In this phase: 64 threads, 2500 requests per thread, 13 waitThreads before next phase could start
Time passed in this phase: 85269 ms
=====================================
=====================================
starting phase3...
There are 57 remaining threads...
In this phase: 6 threads, 2 requests per thread, 0 waitThreads before next phase could start
Time passed in this phase: 33 ms
=====================================
numThreads: 64, numSkiers: 20000, numLifts: 40, numRuns: 20
After all phases:
Number of successful posts: 240012
Number of unsuccessful posts: 0
Wall time: 247seconds
Throughput: 971 requests/sec
Terminating program...
```

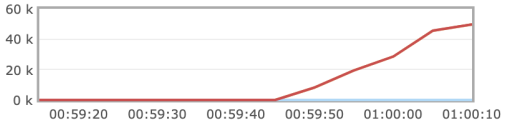
128 Threads

Overview Connections Channels Exchanges Queues Admin

Overview

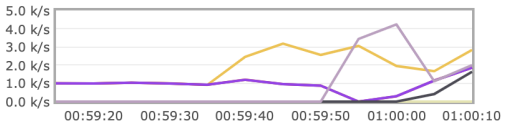
Totals

Queued messages last minute ?



Ready	51,970
Unacked	20
Total	51,990

Message rates last minute ?



Publish	2,830/s
Publisher confirm	0.00/s
Deliver (manual ack)	1,862/s

Deliver (auto ack)	0.00/s
Consumer ack	1,860/s
Redelivered	0.00/s
Get (manual ack)	0.00/s
Get (auto ack)	0.00/s
Get (empty)	0.00/s

Unroutable (return)	0.00/s
Unroutable (drop)	0.00/s
Disk read	1,638/s
Disk write	2,000/s

```
Please Enter numThreads, numSkiers, numLifts, numRuns, seperated by a white space
128 20000 40 20
Please Enter IP and port, seperated by a white space
lb2-681239996.us-west-2.elb.amazonaws.com 80
numThreads | numSkiers | numLifts | numRuns:
[128, 20000, 40, 20]
Total threads: 173
=====================================
starting phase1...
There are 32 concurrent threads...
In this phase: 32 threads, 2500 requests per thread, 7 waitThreads before next phase could start
Time passed in this phase: 81348 ms
=====================================
=====================================
starting phase2...
There are 153 concurrent threads (including those from phase1) at start...
In this phase: 128 threads, 1250 requests per thread, 26 waitThreads before next phase could start
Time passed in this phase: 57390 ms
=====================================
=====================================
starting phase3...
There are 113 remaining threads...
In this phase: 13 threads, 2 requests per thread, 0 waitThreads before next phase could start
Time passed in this phase: 147 ms
=====================================
numThreads: 128, numSkiers: 20000, numLifts: 40, numRuns: 20
After all phases:
Number of successful posts: 240026
Number of unsuccessful posts: 0
Wall time: 139seconds
Throughput: 1726 requests/sec
Terminating program...
```

256 Tthreads

RabbitMQ™ RabbitMQ 3.9.13 Erlang 24.2.2

Refreshed 2022-03-11 01:06:18 Refresh every 5 seconds

Virtual host All

Cluster **rabbit@my-rabbitmq**

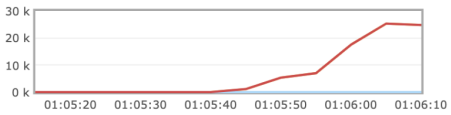
User **user** Log out

Overview | **Connections** | **Channels** | **Exchanges** | **Queues** | **Admin**

Overview

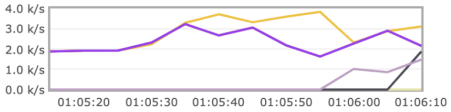
Totals

Queued messages last minute ?



Ready	24,292
Unacked	20
Total	24,312

Message rates last minute ?



Publish	3,107/s	Deliver (auto ack)	0.00/s
Publisher confirm	0.00/s	Consumer ack	2,154/s
Deliver (manual ack)	2,156/s	Redelivered	0.00/s
		Get (manual ack)	0.00/s
		Get (auto ack)	0.00/s
		Get (empty)	0.00/s

Unroutable (return)	0.00/s
Unroutable	0.00/s

```
Please Enter numThreads, numSkiers, numLifts, numRuns, seperated by a white space
256 20000 40 20
Please Enter IP and port, seperated by a white space
lb2-681239996.us-west-2.elb.amazonaws.com 80
numThreads | numSkiers | numLifts | numRuns:
[256, 20000, 40, 20]
Total threads: 346
=====================================
starting phase1...
There are 64 concurrent threads...
In this phase: 64 threads, 1250 requests per thread, 13 waitThreads before next phase could start
Time passed in this phase: 44024 ms
=====================================
=====================================
starting phase2...
There are 307 concurrent threads (including those from phase1) at start...
In this phase: 256 threads, 625 requests per thread, 52 waitThreads before next phase could start
Time passed in this phase: 48638 ms
=====================================
=====================================
starting phase3...
There are 224 remaining threads...
In this phase: 26 threads, 2 requests per thread, 0 waitThreads before next phase could start
Time passed in this phase: 150 ms
=====================================
numThreads: 256, numSkiers: 20000, numLifts: 40, numRuns: 20
After all phases:
Number of successful posts: 240052
Number of unsuccessful posts: 0
Wall time: 94seconds
Throughput: 2553 requests/sec
Terminating program...
```

512 Threads

RabbitMQ 3.9.13 Erlang 24.2.2

Virtual host All

Cluster **rabbit@my-rabbitm**

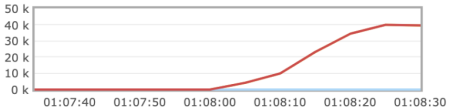
User **user** Log ou

Overview | **Connections** | **Channels** | **Exchanges** | **Queues** | **Admin**

Overview

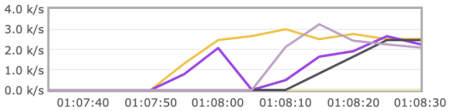
Totals

Queued messages last minute ?



Ready	38,814
Unacked	20
Total	38,834

Message rates last minute ?



Publish	2,520/s
Publisher confirm	0.00/s
Deliver (manual ack)	2,255/s

Deliver (auto ack)	0.00/s
Consumer ack	2,254/s
Redelivered	0.00/s
Get (manual ack)	0.00/s
Get (auto ack)	0.00/s
Get (empty)	0.00/s

Unroutable (return)	0.00/s
Unroutable (drop)	0.00/s
Disk read	2,458/s

```
Please Enter numThreads, numSkiers, numLifts, numRuns, seperated by a white space
512 20000 40 20
Please Enter IP and port, seperated by a white space
lb2-681239996.us-west-2.elb.amazonaws.com 80
numThreads | numSkiers | numLifts | numRuns:
[512, 20000, 40, 20]
Total threads: 691
=====================================
starting phase1...
There are 128 concurrent threads...
In this phase: 128 threads, 625 requests per thread, 26 waitThreads before next phase could start
Time passed in this phase: 30803 ms
=====================================
=====================================
starting phase2...
There are 614 concurrent threads (including those from phase1) at start...
In this phase: 512 threads, 313 requests per thread, 103 waitThreads before next phase could start
Time passed in this phase: 39869 ms
=====================================
=====================================
starting phase3...
There are 459 remaining threads...
In this phase: 51 threads, 2 requests per thread, 0 waitThreads before next phase could start
Time passed in this phase: 130 ms
=====================================
numThreads: 512, numSkiers: 20000, numLifts: 40, numRuns: 20
After all phases:
Number of successful posts: 240358
Number of unsuccessful posts: 0
Wall time: 76seconds
Throughput: 3162 requests/sec
Terminating program...
```

After including more client threads, the throughput has increased as well as the message receive and send rates.
The message receive rates and send rates remain relatively close.
The queue size is close to zero for most of the time.