Evaluation Doc

AWS Deployment

Copy the AWS CLI code and save it to `$HOME/.aws/credentials`

Run "`aws configure`"

1. For AWS Access Key ID, it's already configured in the previous step by creating a credentials file. Just press enter to skip this step.
2. For AWS Secret Access Key, it's also configured in the previous step. Press enter to skip this step.
3. For default region name, input "`us-east-1`".
4. For default output format, input "`json`".

Create an EC2 instance using AWS CLI. Open a terminal and run:

```
aws ec2 run-instances --image-id ami-0d73480446600f555
--instance-type m5a.large --key-name vockey > instance.json
```

For image id we used Ubuntu 18.04 server image provided by Canonical, at the time of writing the latest AMI (Amazon Machine Images) ID is "`ami-0d73480446600f555`"

The "`instance.json`" file will contain the details of your instance. Copy the "InstanceId" field. Now in your terminal check the status of your instance using the following command:

```
aws ec2 describe-instances --instance-id <your-instance-id>
```

Example:

```
aws ec2 describe-instances --instance-id i-07ba1758d2fe611e6
```

Get the public DNS name from the field "`PublicDnsName`":

Example:

```
"ec2-3-83-14-35.compute-1.amazonaws.com"
```

Get the public IP address from the field "`PublicIpAddress`" which will be used by the client to send requests to the front-end:

Example:

```
"3.83.14.35"
```

Download the PEM key and set the right permission for the PEM key.

```
chmod 400 labsuser.pem
```

The other thing we need to do is to authorize port 22 (used by ssh) and port 8000 (used by our front-end service) in the default security group (you can think of security group as a virtual firewall)

```
aws ec2 authorize-security-group-ingress --group-name default
--protocol tcp --port 22 --cidr 0.0.0.0/0

aws ec2 authorize-security-group-ingress --group-name default
--protocol tcp --port 8000 --cidr 0.0.0.0/0
```

Now run ssh to access the instance:

```
ssh -i labsuser.pem ubuntu@<your-instance's-public-DNS-name>
```

Example:

```
ssh -i labsuser.pem
ubuntu@ec2-3-83-14-35.compute-1.amazonaws.com
```

In the EC2 instance terminal, run git clone to clone the lab directory.

```
git clone
https://github.com/umass-cs677-current/spring23-lab-3-677-lab3.g
it
```

Run the catalog service on one terminal:

```
CATALOG_HOST="0.0.0.0" CATALOG_PORT=6000 python3
catalogService.py
```

Run the first order service replica on one terminal:

```
SERVICE_ID="5" ORDER_HOST="0.0.0.0" ORDER_PORT=6001
CATALOG_HOST="0.0.0.0" CATALOG_PORT=6000 ORDER_ID="5,6,8"
FILE_PATH="../data/" ORDER_PORTS="6001,6002,6003"
ORDER_HOSTS="0.0.0.0,0.0.0.0,0.0.0.0" python3 orderService.py
```

Run the second order service replica on one terminal:

```
SERVICE_ID="6" ORDER_HOST="0.0.0.0" ORDER_PORT=6002
CATALOG_HOST="0.0.0.0" CATALOG_PORT=6000 ORDER_ID="5,6,8"
FILE_PATH="../data/" ORDER_PORTS="6001,6002,6003"
ORDER_HOSTS="0.0.0.0,0.0.0.0,0.0.0.0" python3 orderService.py
```

Run the third order service replica on one terminal:

```
SERVICE_ID="8" ORDER_HOST="0.0.0.0" ORDER_PORT=6003
CATALOG_HOST="0.0.0.0" CATALOG_PORT=6000 ORDER_ID="5,6,8"
FILE_PATH="../data/" ORDER_PORTS="6001,6002,6003"
ORDER_HOSTS="0.0.0.0,0.0.0.0,0.0.0.0" python3 orderService.py
```

Run the front-end service on one terminal:

```
CACHE_SIZE=5 FRONTEND_HOST="0.0.0.0" FRONTEND_PORT=8000
CATALOG_HOST="0.0.0.0" CATALOG_PORT=6000
ORDER_HOSTS="0.0.0.0,0.0.0.0,0.0.0.0" ORDER_ID="5,6,8"
ORDER_PORTS="6001,6002,6003" python3 front-end-http-server.py
```

Run the clients on the localhost:

```
python3 client.py <PublicIPAddress> <port>
```

Example:

```
python3 client.py "3.83.14.35" 8000
```

At the end kill the instance:

```
aws ec2 terminate-instances --instance-ids <your-instance-id>
```

Example:

```
aws ec2 terminate-instances --instance-ids  i-07ba1758d2fe611e6
```

Measurement results and plots

The services were run on AWS while 5 clients were running on localhost

Cache size = 5

Probability p: 1
Total stock lookup requests: 200
Average stock lookup time : 60.978801250457764ms
Total trade requests: 147
Average trade time : 68.20844955184832ms
Total order lookup requests: 147
Average order lookup time: 67.5786255168266ms
Probability p: 0.8
Total stock lookup requests: 200
Average stock lookup time : 64.64371681213379ms
Total trade requests: 133
Average trade time : 75.37950967487537ms
Total order lookup requests: 133
Average order lookup time: 51.362968028936166ms
Probability p: 0.6
Total stock lookup requests: 200
Average stock lookup time : 59.05776500701904ms
Total trade requests: 94
Average trade time : 68.71852976210575ms
Total order lookup requests: 94
Average order lookup time: 52.490183647642745ms
Probability p: 0.4
Total stock lookup requests: 200

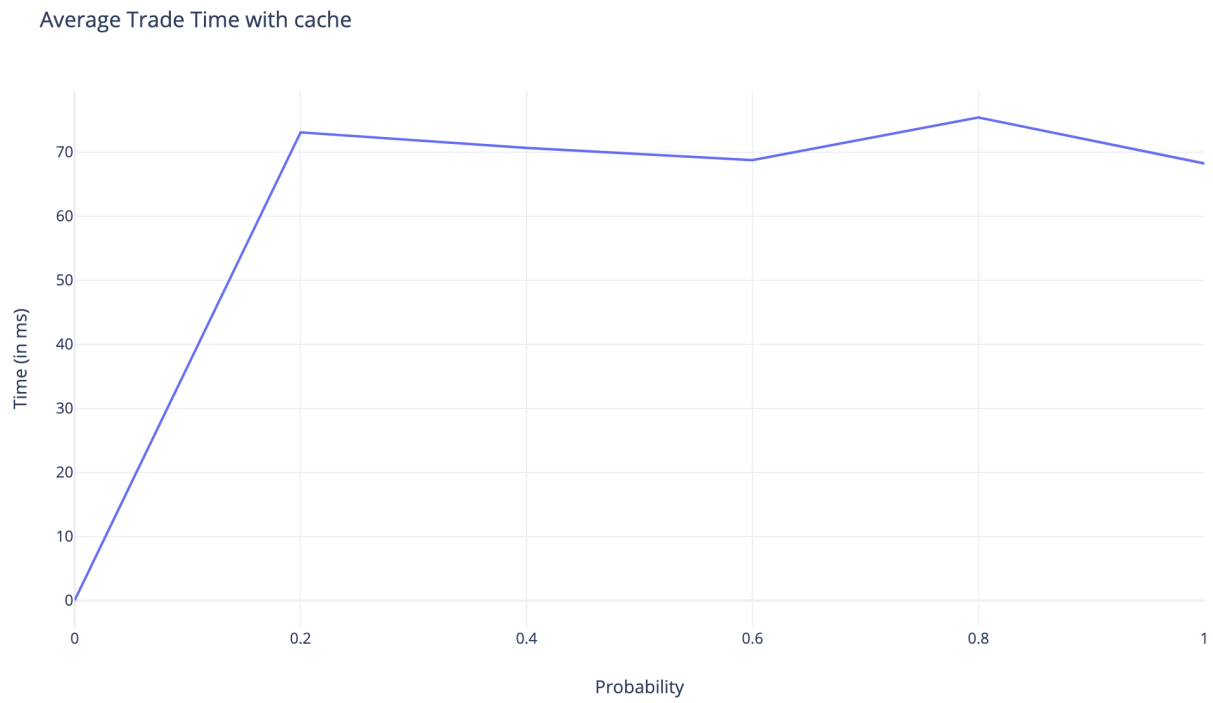
Average stock lookup time : 60.526771545410156ms
Total trade requests: 59
Average trade time : 70.62234312801039ms
Total order lookup requests: 59
Average order lookup time: 75.02286717043084ms
Probability p: 0.2
Total stock lookup requests: 200
Average stock lookup time : 63.28652620315552ms
Total trade requests: 32
Average trade time : 73.05673509836197ms
Total order lookup requests: 32
Average order lookup time: 76.7182856798172ms
Probability p: 0
Total stock lookup requests: 200
Average stock lookup time : 60.129263401031494ms
Total trade requests: 0
Average trade time : 0ms
Total order lookup requests: 0
Average order lookup time: 0ms

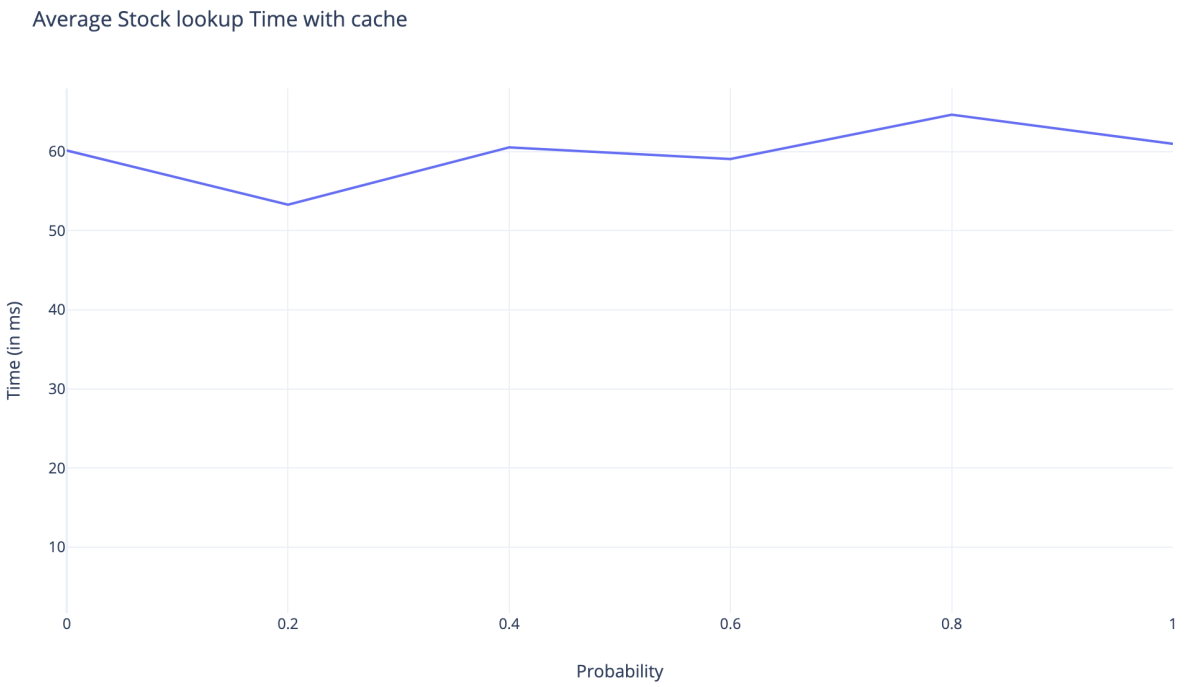
Cache size = 0

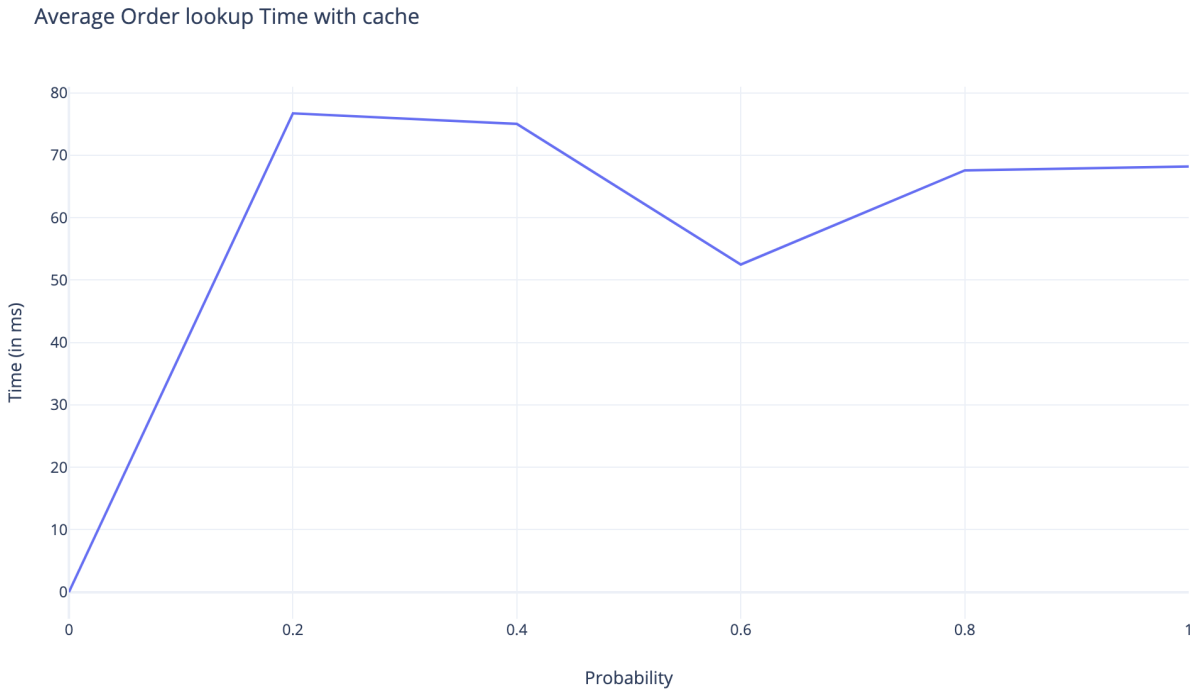
Probability p: 1
Total stock lookup requests: 200
Average stock lookup time : 64.55180168151855ms
Total trade requests: 160
Average trade time : 76.81950628757477ms
Total order lookup requests: 160
Average order lookup time: 78.76510918140411ms
Probability p: 0.8
Total stock lookup requests: 200
Average stock lookup time : 60.62765598297119ms
Total trade requests: 120
Average trade time : 73.18808436393738ms
Total order lookup requests: 120
Average order lookup time: 72.20473686854044ms
Probability p: 0.6
Total stock lookup requests: 200
Average stock lookup time : 65.66105127334595ms
Total trade requests: 88
Average trade time : 76.36974345554006ms
Total order lookup requests: 88
Average order lookup time: 77.60420441627502ms

Probability p: 0.4
Total stock lookup requests: 200
Average stock lookup time : 65.53163528442383ms
Total trade requests: 60
Average trade time : 76.1860728263855ms
Total order lookup requests: 60
Average order lookup time: 75.54608980814616ms
Probability p: 0.2
Total stock lookup requests: 200
Average stock lookup time : 64.61419582366943ms
Total trade requests: 29
Average trade time : 104.62367123570935ms
Total order lookup requests: 29
Average order lookup time: 78.58435038862558ms
Probability p: 0
Total stock lookup requests: 200
Average stock lookup time : 61.11002564430237ms
Total trade requests: 0
Average trade time : 0ms
Total order lookup requests: 0
Average order lookup time: 0ms

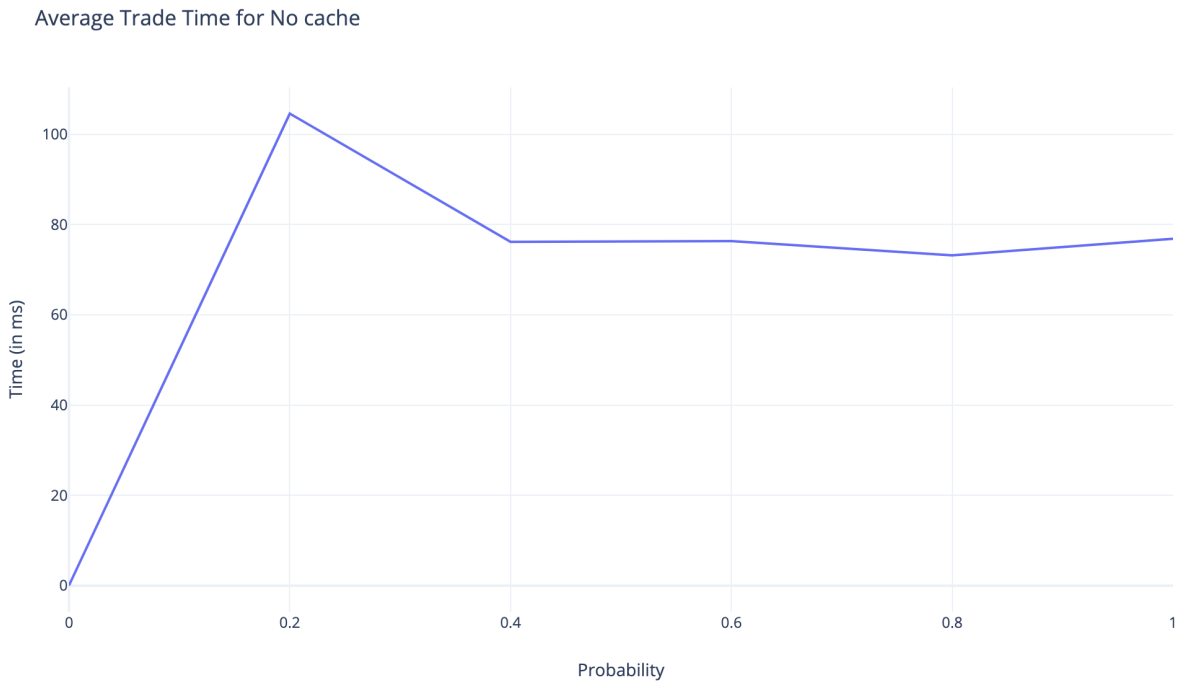
- **Plots for times measured with cache:**

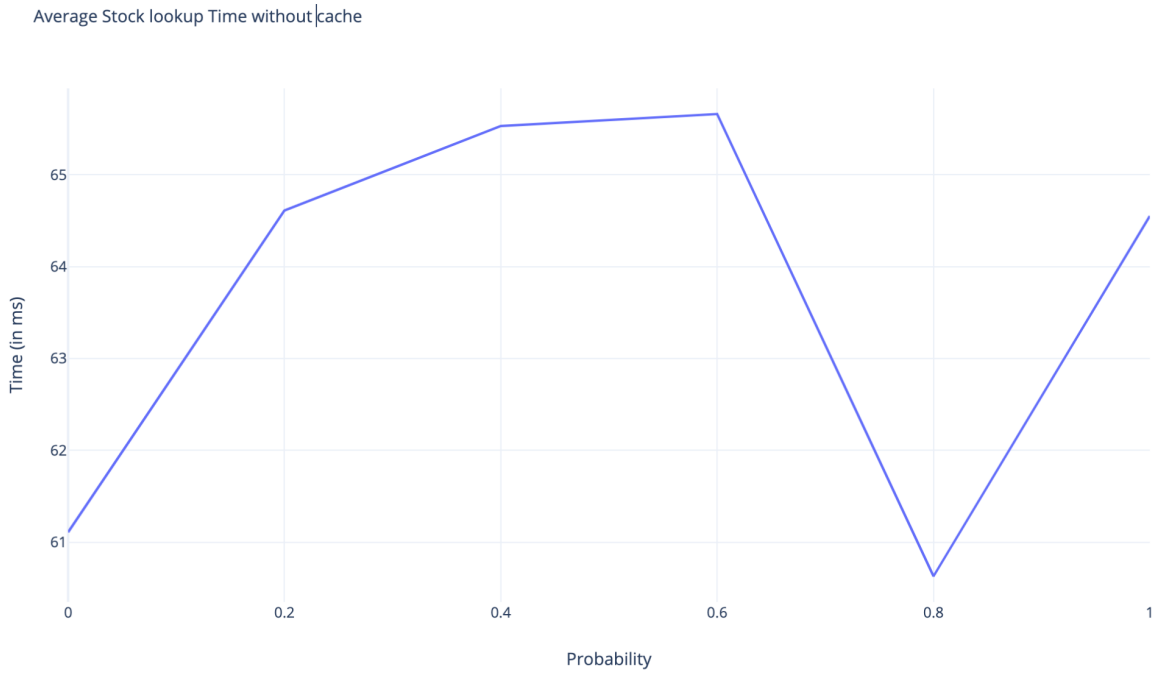


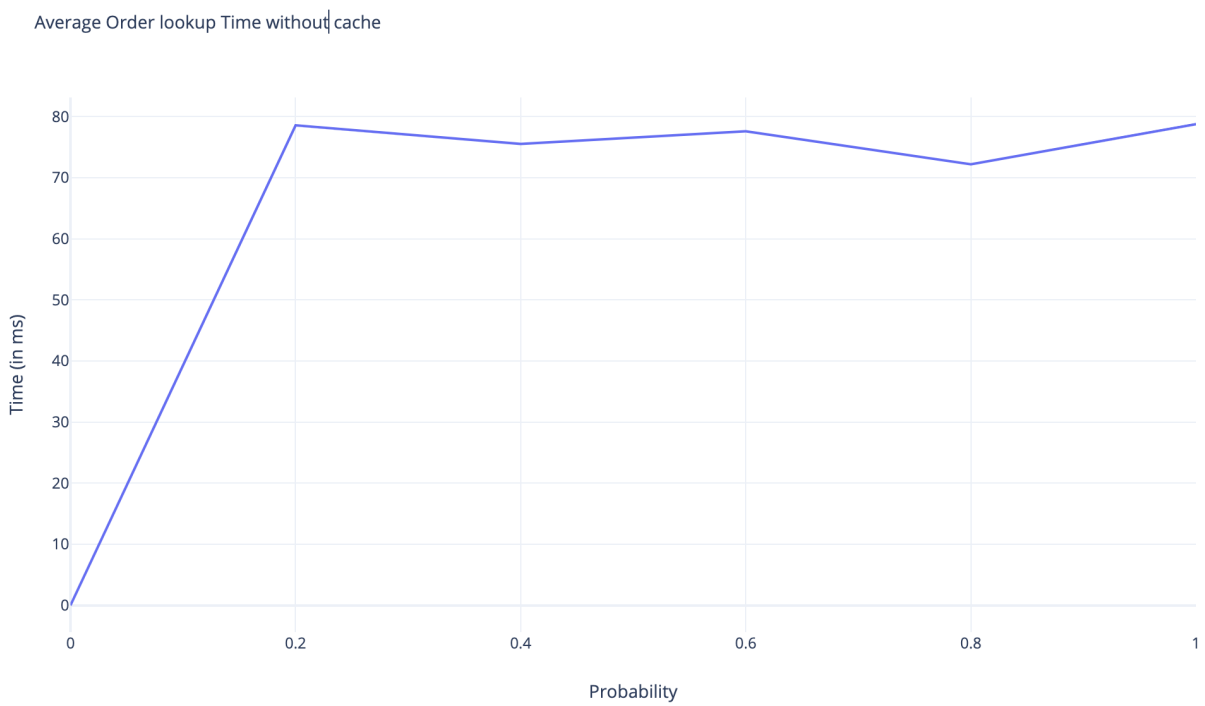

Average Stock lookup Time with cache
Time (in ms)
60
50
40
30
20
10
0
0.2
0.4
0.6
0.8
1
Probability


Average Order lookup Time with cache
Time (in ms)
80
70
60
50
40
30
20
10
0
0
0.2
0.4
0.6
0.8
1
Probability

- Plots for times measured without cache:







Observations:

1. Trade time was significantly lower when cache was used.
2. Stock lookup time was lower using cache than no cache.
3. Order lookup was slower when cache was not used.

Questions

Q1.Finally, simulate crash failures by killing a random order service replica while the client is running, and then bring it back online after some time. Repeat this experiment several times and make sure that you test the case when the leader is killed.
Can the clients notice the failures? (either during order requests or the final order checking phase) or are they transparent to the clients?
Ans: Tested by abruptly killing leader and follower services, and restarting them. The clients didn't notice any failures, as failures were taken care of by electing new leader and continuing serving requests using the new leader. Failures are transparent to the clients.

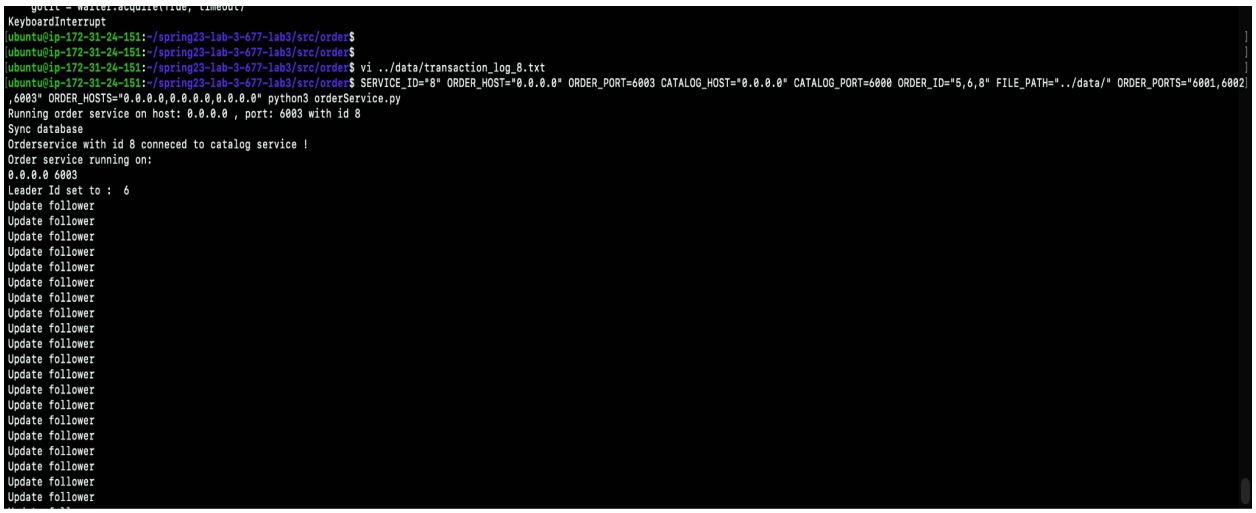
When the killed service was restarted, its database was updated by communicating with replicas and once updated it continued being synchronized with the service leader.

```
data:
{'data': {'name': 'Wheely', 'price': 64.2300033569336, 'quantity': 1969}}
Stock Quantity: 1969
Sending Trade request for stockname: Wheely , type: sell
response.status, response.reason, response.version :
200 OK 11
data:
{'data': {'transaction_number': 9886}}
Sending Lookup request for stockname: InvalidStockName
404 Not Found 11
data:
{'error': {'code': 404, 'message': 'stock not found'}}
Sending Lookup request for stockname: CarCo
200 OK 11
data:
{'data': {'name': 'CarCo', 'price': 45.0, 'quantity': 2002}}
Stock Quantity: 2002
Sending Trade request for stockname: CarCo , type: buy
response.status, response.reason, response.version :
200 OK 11
```

```
Update follower
Update follower
Update follower
Update follower
Update follower
Update follower
Update follower
Update follower
Leader Id set to :  6
error: NO_ERROR
stockname: "CarCo"
price: 45
quantity: 2001

error: NO_ERROR
stockname: "MenhirCo"
price: 234.3
quantity: 1254

error: NO_ERROR
stockname: "GameStart"
price: 15.99
quantity: 9080

error: NO_ERROR
stockname: "TheaterCo"
price: 91.99
quantity: 2030
```

After leader order service with service id 8, the order service with service id 6 becomes the leader and starts serving requests. The client requests keep getting served by the new leader even if the old leader is down.

Once the leader is restarted, it becomes the follower while service id 6 still remains the leader.



Q2. Do all the order service replicas end up with the same database file?
Ans. Yes, all replicas end up with identical database files .

The order service replica database after it was stopped:

```
9859 - Stockname: ConStock  Quantity: 1 Order: sell
9860 - Stockname: MenhirCo  Quantity: 1 Order: buy
9861 - Stockname: BoarCo  Quantity: 1 Order: buy
9862 - Stockname: Wheely  Quantity: 1 Order: sell
9863 - Stockname: FishCo  Quantity: 1 Order: sell
9864 - Stockname: GameStart  Quantity: 1 Order: buy
9865 - Stockname: MenhirCo  Quantity: 1 Order: buy
9866 - Stockname: GameStart  Quantity: 1 Order: sell
9867 - Stockname: MenhirCo  Quantity: 1 Order: sell
9868 - Stockname: FishCo  Quantity: 1 Order: buy
9869 - Stockname: TheaterCo  Quantity: 1 Order: buy
9870 - Stockname: MenhirCo  Quantity: 1 Order: buy
9871 - Stockname: Wheely  Quantity: 1 Order: buy
9872 - Stockname: BoarCo  Quantity: 1 Order: sell
9873 - Stockname: MenhirCo  Quantity: 1 Order: sell
9874 - Stockname: MenhirCo  Quantity: 1 Order: buy
9875 - Stockname: CarCo  Quantity: 1 Order: sell
9876 - Stockname: MenhirCo  Quantity: 1 Order: buy
```

The order service replica database after it was restarted:

```
9870 - Stockname: MenhirCo  Quantity: 1 Order: buy
9871 - Stockname: Wheely  Quantity: 1 Order: buy
9872 - Stockname: BoarCo  Quantity: 1 Order: sell
9873 - Stockname: MenhirCo  Quantity: 1 Order: sell
9874 - Stockname: MenhirCo  Quantity: 1 Order: buy
9875 - Stockname: CarCo  Quantity: 1 Order: sell
9876 - Stockname: MenhirCo  Quantity: 1 Order: buy
9877 - Stockname: CarCo  Quantity: 1 Order: sell
9878 - Stockname: MenhirCo  Quantity: 1 Order: buy
9879 - Stockname: GameStart  Quantity: 1 Order: buy
9880 - Stockname: TheaterCo  Quantity: 1 Order: sell
9881 - Stockname: TheaterCo  Quantity: 1 Order: sell
9882 - Stockname: GameStart  Quantity: 1 Order: sell
9883 - Stockname: MenhirCo  Quantity: 1 Order: buy
9884 - Stockname: MenhirCo  Quantity: 1 Order: sell
9885 - Stockname: MenhirCo  Quantity: 1 Order: buy
9886 - Stockname: Wheely  Quantity: 1 Order: sell
9887 - Stockname: CarCo  Quantity: 1 Order: buy
9888 - Stockname: CarCo  Quantity: 1 Order: buy
9889 - Stockname: BoarCo  Quantity: 1 Order: buy
9890 - Stockname: MenhirCo  Quantity: 1 Order: buy
9891 - Stockname: ConStock  Quantity: 1 Order: sell
```

The killed replica synchronizes with other replicas after starting and starts updating its database with the updates it gets from the leader.
In our implementation all the replicas ended up with the same contents in database file, even when a service was killed and then restarted after some time.