

COP5615 Distributed Operating System Principals: Project - 1

Submitted By:

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Background

In this project, you have to use exclusively the AKKA actor library in F# (projects that do not use multiple actors or use any other form of parallelism will receive no credit). A model similar to the one indicated in class for the problem of adding up a lot of numbers can be used here, in particular, defining worker actors that are given a range of problems to solve and a boss that keeps track of all the problems and performs the job assignment. Here we are required to use the SHA256 Hash Function and generate hashes. If we find hashes that contain k leading 0's at the beginning then a Bitcoin is mined.

System Requirements

1. Multicore system
2. .NET SDK installed
3. F# language server for .Net installed
4. Ionide extension for F Sharp if working with Visual Studio Code

Steps to run

1. The name of the project is **BitcoinMiner.fsx**
2. To run the program, type in “**dotnet fsi BitcoinMiner.fsx**” on the terminal (make sure dotnet.exe path is defined on \$PATH)

System tested on

1. Processor: 1.8 GHz AMD Ryzen 7 (Octa-core)
2. Memory: 16GB

Assumptions

1. In order to have a successful match, the hash generated should have K leading zeroes.
2. An increase in the number of actors will increase the possibility of finding more possible combinations leading to more hash generation and an increase in the probability of finding more Bitcoins. If there are n actors then upto n combinations will be iterated.

Observations

We have taken 6 worker actors. The entire job is divided between each of the actors equally ie: each worker gets to compute N/6 units of the work from the boss actor. For the given problem statement, the boss actor gets input work in the magnitude of 26 choose 4 (ie 230230 work units). The more the number of combinations the more hashes will be generated which will result in an increased probability of finding hashes with k leading zeroes.

The CPU/ Real-time ratio achieved is 1.71 using 6 workers.

1. **Size of work unit:** Since we have 26 characters in the hash function (ie: a-z), and we need combinations of 6 characters. Our total work unit achieved is:

$$C_6(26) = \binom{26}{6} = \frac{26!}{6!(26-6)!} = \frac{26 \cdot 25 \cdot 24 \cdot 23 \cdot 22 \cdot 21}{6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1} = 230230$$

Work Units = 230230

2. **Result of running for input 4:**

```
PS C:\Users\rachi\OneDrive\Desktop\DOSP\dosp\Project_1> dotnet fsi .\BitcoinMiner.fsx
Real: 00:00:00.000, CPU: 00:00:00.000, GC gen0: 0, gen1: 0, gen2: 0
Bitcoin mining started!
rachit.rathibhjtwx      0000305fe636bcc18c0b0bfe47cbf8022dd76dcfc841b46e78a77fde388c3931
rachit.rathiekmpsy      00003a2c022cdb55b6c57ba324c4fbc03f4c75252843e1ead61650cacf7745fd
Bitcoin mining ended!
Real: 00:00:01.700, CPU: 00:00:02.906, GC gen0: 789, gen1: 15, gen2: 1
PS C:\Users\rachi\OneDrive\Desktop\DOSP\dosp\Project_1> 
```

3. CPU/Real-time ratio:

- a. CPU time: 02.906s
- b. Real-Time: 01.700s
- c. **CPU/Real-time ratio: CPU Time/Real-Time = 1.71 (>1, therefore parallelism exists)**

- 4. The coin with the most zeros:** Optimal performance achieved having K=4. For K > 4 we did not find any bitcoins for the given actors. There are two coins, *“rachit.rathibhjtwx”* and *“rachit.rathiekmpsy”* that match the k value for leading zeroes.

Client-Server Distributed System

In the client-server architecture actors on both the server-side and client-side are performing their respective tasks. The client-side is performing combinations of six and the server-side is performing combinations of seven and as soon as the operation is performed by the server the response of combinations found is sent to the client.

Steps to run

- 3. To run the program, got to folder **Client_Server** and type in *“dotnet fsi server.fsx”* on the terminal (make sure dotnet.exe path is defined on \$PATH) on System 2
- 4. To run the client, got to folder **Client_Server** and type in *“dotnet fsi client.fsx [ip-address@System2] [port number@System2]”* on System 1

```

Real: 00:00:00.000, CPU: 00:00:00.000, GC gen0: 0, gen1: 0, gen2: 0
Bitcoin mining started!
[INFO][9/23/2021 3:41:17 AM][Thread 0001][remoting (akka://ClientFsharp)] Starting remoting
[INFO][9/23/2021 3:41:17 AM][Thread 0001][remoting (akka://ClientFsharp)] Remoting started; listening on addresses : [akka.tcp://ClientFsharp@localhost:8778]
[INFO][9/23/2021 3:41:17 AM][Thread 0001][remoting (akka://ClientFsharp)] Remoting now listens on addresses: [akka.tcp://ClientFsharp@localhost:8778]
Bitcoin mining started!
From Client
rachit.rathibhjtwx      0000305fe636bcc18c0b0bfe47cbf8022dd76dcfc841b46e78a77fde388c3931
From Client
rachit.rathiekmpsy      00003a2c022cdb55b6c57ba324c4fbc03f4c75252843e1ead61650cacf7745fd
From Server
rachit.rathibhjtwx      0000305fe636bcc18c0b0bfe47cbf8022dd76dcfc841b46e78a77fde388c3931
From Server
rachit.rathiacmnqsu     00007c6ad3e80ae373cf3f8e7e7714ad46cbea3e6d108200fc4f634203556577
From Server
rachit.rathiekmpsy      00003a2c022cdb55b6c57ba324c4fbc03f4c75252843e1ead61650cacf7745fd
From Server
rachit.rathibcdhjnu     00004743d12e5ebac907cc39ddc17fa0236420715ab3f8baaff34be69651487
From Server
rachit.rathibdekmox     0000e46c2674bc53ee7ad7343ec6647c0663b3e2ee54c6988e38a9a9f239f10e
From Server
rachit.rathicdefkmu     0000609ab8c52d9cd0ae5b5555ca24aa07afdddc5a5d771447f783db497b6cc
From Server
rachit.rathicdoqtzx     0000d4dc00525c7036c10fbb88d782c881df9523b8c6a422a41f4e01b7b2cd82
From Server
rachit.rathicghkrwz     0000b0d06e7bd7ab2493307eab60528e962eff36752344463b54dd0b96c181d2
From Server
rachit.rathiegoruwz     0000ebdaea86ed7746c8e1e8392ccb01e00270090e9e7761c202444dafab208
From Server
rachit.rathifhjkllwx    000057dbc5b5ae7201ac6e9c098da8c3d0d9f0263d51d3c0ec5f240e56df1626
From Server
rachit.rathiglknosy     0000947ffe6abb48670af8e319db46dc6e791b25b194881d67a60eeaba3f4699
From Server
rachit.rathijnsuyz      000014fdbd1540816ae1d6f85fdb7ecf1c55390116e9a70c75c2aa869f0e7d8
From Server
rachit.rathijmopuvz     0000b49d7fc9e9ab3507d384b56e9118fa1213373665cebaadbaf616b977fcc1
[INFO][9/23/2021 3:41:25 AM][Thread 0038][remoting-terminator] Shutting down remote daemon.
[INFO][9/23/2021 3:41:25 AM][Thread 0038][remoting-terminator] Remote daemon shut down; proceeding with flushing remote transports.
[INFO][9/23/2021 3:41:25 AM][Thread 0028][akka.tcp://ClientFsharp@localhost:8778/system/endpointManager/reliableEndpointWriter-akka.tcp%3A%2F%2FRemoteFSharp%40localhost%3A8778-1]
r [akka.tcp://ClientFsharp@localhost:8778]->[akka.tcp://RemoteFSharp@10.3.2.220:3000]
[INFO][9/23/2021 3:41:25 AM][Thread 0051][remoting (akka://ClientFsharp)] Remoting shut down
[INFO][9/23/2021 3:41:25 AM][Thread 0027][remoting-terminator] Remoting shut down.
Bitcoin mining ended!
Real: 00:00:07.868, CPU: 00:00:04.250, GC gen0: 792, gen1: 17, gen2: 1

```

System 1 (client): 1.8 GHz AMD Ryzen 7. Memory: 16 GB

```

➔ dosp-tester dotnet fsi server3.fsx
Real: 00:00:00.000, CPU: 00:00:00.000, GC gen0: 0, gen1: 0, gen2: 0
[INFO][23/09/2021 03:40:44][Thread 0001][remoting (akka://RemoteFSharp)] Starting remoting
[INFO][23/09/2021 03:40:44][Thread 0001][remoting (akka://RemoteFSharp)] Remoting started; listening on addresses : [akka.tcp://RemoteFSharp@10.3.2.220:3000]
[INFO][23/09/2021 03:40:44][Thread 0001][remoting (akka://RemoteFSharp)] Remoting now listens on addresses: [akka.tcp://RemoteFSharp@10.3.2.220:3000]
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
Sent to client
[INFO][23/09/2021 03:41:25][Thread 0015][remoting-terminator] Shutting down remote daemon.
[INFO][23/09/2021 03:41:25][Thread 0015][remoting-terminator] Remote daemon shut down; proceeding with flushing remote transports.
[INFO][23/09/2021 03:41:25][Thread 0018][akka.tcp://RemoteFSharp@10.3.2.220:3000/system/endpointManager/reliableEndpointWriter-akka.tcp%3A%2F%2FClientFSharp%40localhost%3A8778-1] Removing receive buffers for [akka.tcp://RemoteFSharp@10.3.2.220:3000]->[akka.tcp://ClientFsharp@localhost:8778]
[WARNING][23/09/2021 03:41:25][Thread 0020][TcpServerHandler (akka://RemoteFSharp)] Unable to REMOVE channel [::ffff:10.3.2.220]:3000->[::ffff:10.206.14]:50465(Id=6db86a47) from connection group. May not shut down cleanly.
[INFO][23/09/2021 03:41:25][Thread 0027][remoting (akka://RemoteFSharp)] Remoting shut down
[INFO][23/09/2021 03:41:25][Thread 0015][remoting-terminator] Remoting shut down.
Real: 00:00:41.129, CPU: 00:00:09.809, GC gen0: 2671, gen1: 69, gen2: 2

```

System 2 (server): 2.3 GHz Intel i5 (Dual-Core), Memory: 8GB

5. CPU/Real-time ratio for Client-Server distributed system:

d. CPU time: $\text{CPU1} + \text{CPU2} = 4.250\text{s} + 9.809\text{s} = 14.059\text{s}$

e. Real-Time: 7.868s

f. **CPU/Real-time ratio: $\text{CPU Time/Real Time} = 1.79$ (>1 , therefore parallelism exists)**

Conclusion: In the client-server architecture, the CPU/Real-time ratio comes out to be ~ 1.79 which is greater than the one obtained while running on a single system for the same amount of computation ($K=4$). Therefore, the performance has been enhanced with the introduction of a multi-system architecture.