

COP5615 Distributed Operating System

Project 1

Group Members

1. Bhavya Kavdia, UFID : 7017-7277
2. Ishita Trivedi, UFID : 6893-6496

Steps to run the Code

1. Go to the folder Project1.zip (where Program1.fsx file is present)
2. Use the command : "dotnet fsi Program1.fsx <input>"

Number of Parent and Children Actors with work unit –

We are generating a parent or a boss actor that dynamically generates up to 30 (for generating bitcoins with 4 and 5 leading zeroes) or 100 (for generating bitcoin with 6 leading zeroes) child actors. Each child gets a work of 100000 unit wherein it calculates hash of randomly generated strings. We have used the random function in F# to generate strings of length varying from 10 to 20 and which are prepended by our gator link ID i.e. "itrivedi".

For example if 30 children are created then each child would have "itrivedi" as the prefix and the first character of the remaining string would also be fixed {for child 1 – A, for child 2- B and so on} and it will be one of the character from the following set of values [ABCDEFGHIJKLMNPOQRSTUVWXYZ0123456789], followed by random 10- 20 character strings as follows:-

Child Actor 1 -> itrivediA{10-20 character string}

Child Actor 2 -> itrivediB{10-20 character string}

Child Actor 3 -> itrivediC{10-20 character string}

.
. .
.

Child Actor 30 -> itrivedi3{10-20 character string}

- We have determined that dividing the child actors in this size and manner approximately utilizes all the 4 machine cores when running on a quad core machine and speeds up the process as each child actor handles numbers of equal size and different random strings.

#Result of running dotnet fsi Program1.fsx 4

itrivediAFK4FCP1GXS8KQWY 0000408eb69fe7714deed8e89aca39921c1e22df867ef124c0c2537b434a1ebf

itrivediFWFX5G2SA6BPEIQ9XE7 0000f212f3f36ab85071b95bd9891cc1bd86950a9eb0a6e6187044e8060f26d8

itrivediBUJUWDC64F 00009311ff71dc8c0af5ffe44e3e580a353fabe04a598ab739b8aea46ebf9473

itrivediB6ZKG5U5JMU 000050e5fc7088568bce22a3cae8cbd9a9b3cdad922a1f27c8ac252f83ec71e8

itrivediG9O41XURJGDZE4LOBBT 00002ddda625b141bdfc7207292e1a4ba1adf02d67d012dcc3a0f0723b317fcd

itrivediAVZQZUREBQR710S0UMG1 000030effca95780d77cfde7e781475456fc840066a433be198cc4d8a38e91b1

itrivediGGCRQBRYRM2TRNW8 00006d120632fb38c3ba336552307a0fcc3b94fc53e82d44135f65976c5713a3

itrivediEOQT0F29QJ 00005bd33842ea6e9f58405ffc56a07146589247577f5116abee408846beae23

itrivediEEHUZLGZKYUQVWBU38SW 00000666f535a70958f057c0f0300e2948a6cc28c834f9fdcd2daba812692144

itrivediAL9MKEQM18D87CD0X0 0000acc5caa1ae5619eb7df568a0e255a5d6c5521052f2869048f5f0d9040d71

itrivediA5GJXA4DV418LV23941B 0000dbc69cb1e588d3a0964797e1206c4e9ac9c45f8bec0a04a20b2042f011b9

itrivediA9W4FMTI1VPT 00007c7bb1dd3f9fb9773191be9679fd66cbd6943d4d9dfb038a844eff4f1842

itrivediJZU3B37I6J5U 00005935951975bc3e4ce425bd16960a0781a595b0e425f9642e2b5662f9d3c0

itrivediJUZV0Q65EZL 000006ac337b1d8f00dc573a6a614875c15136f79cccd01452f8fa7b531930e0

itrivediPXEFWHNEOP8A6KUC 00005985832c971f76100aa98d573579983e8464e66411913776658f2dd43434

itrivediO92RK9LN6UH2PPM7 0000836e699aadfe632eda2644943baa7aa0d15edd5c08a9b73305d31f1e3c1b

itrivediLGSDYBO71HDM7H 0000473140c66751ad72af165252bf0eb32fcfe7d43ac9d7ce44753d260413ec

itrivediMZULLONHKTIEK8 00000b888e38d777545f1a8853dbe56d402d78a813efdf23d04aa6e297282e29

itrivediJ9UOCJU407 000067b7ddf9890fe0e06c8a4051a7e13a8beef8b8a94cf19bc6a73b239198db

itrivediINQNGMBO4522JF3SO 00005e2c0f6e8a6dd223b574d38ad3f15d36888869f84796b5ca252edf8b69ac

itrivediQIC6RGNXD525P7A3FZF 0000aab487f3388a3600654cbdbdc52b3a72e9e9cab56a538392d061c6abad7a6

itrivediKUAUIZVUB1F8UJXO1SG 0000e601b867fb42b561581e343fe1542398b90572edf7d901be19b98883da4f

itrivediJ2GQODX938YC0TPW0XE 00004bd4e43f6d456c5056118b7ccf934877b53768355e3b4c5c0d560e5b5f2b

itrivediLYCUOQ4WBNRQU0ERUZG3 00005e976a51ae5750beec3906ae84b833272e8faf43bf102f95e57503459da1

itrivediJ5VQRGU00QGW73AIW 00001004ce2e41bcb0e5c1cec6d931786715b0f185325fa71063eeeddab6f3b7

itrivediN5RCKAZ2R9B 00002769f389190ef70f86735bb52b85719a11c54fad2402179e99570b21b704

itrivediV531H89PO9OJ5Y2B4I 00003f6d2b8aaf31dc6ab5d7d989b2e8343b68dd56e2438df4257d7164d6faaf

itrivediVXSXAWIGTS4CSB18J8 00004ce70d35782de2c34d93aa546a9adf5cb95cca9e49832e803d3945a60ea7

itrivediSXAIO4E7WV 0000829e5ee20673fbecd53d7c99d944b6c7d6645aca1940664159e777d713ab

itrivediWYZUSZWG9EP 00004953484ee899d6d987d0a86b4ecc26f1e18b496ec675ce2142603a9dae30

itrivediRKS04O2R0IBOR3V0WL2 00005e4d104f7dcff183406dc65d4916c16e780d92e00c4b28dc3f1134541ef7

itrivediTHI6AZE2YUFVDPE1 0000b017cac59b2c11d093554d7c3fc11310f0d75327fa280aa7d42fee059d99

itrivediTBUVF7GLIG4AEI 000041d881dec4049ed94f31355db45a389f7efb3532e253169edef94d934d40

itrivediYJAGX83CDQ 0000440ca2ddcdf3ba4fa5b5e75e2366e05c0047ac677fb24cd3080e2b832b74

itrivediT986JUTT9HUFWRHF 00008bc8077e654b7cc2cf4ed26a8ac1bc38a1619ed739164040973cfbfc0580

itrivediSUNKI6GKISMF4WO 0000ed8411e7fd5023673d7360e1d1b8106b2e6a8799898b0e5fe70f1cc52ff7

itrivediYE6URMNAU4EFB 0000174bd93b6015463f42cb14b9ce39bf4cd3f64a495a9ee64ff8942d2ae5f6

itrivediYUAXTHN6TW7NGJRR6S 00003940a03d3f4f8cc70d17241a6cc47999103555da87d4a026d2964a9787f9

itrivediWR1UUMDHZQ9RZ1 000003ebce49ac6997b1157c420a27c8d24503073d61ec4a753ea35f092dab93

itrivediYVGS103TRZ44UMMV40 0000a56beb3959c8a9335abaede2c91a37db47ede1ed3178ba205f454ee8791a

itrivediVU736TUK5T8 0000f75e5f907e1b5642752a5c88ea853a85171394f90b6c443db3c145c31948

itrivediUSSWY23W03UJNDZFXDL 00004a4e5b87a6f0ad7a8dac2adc7b53fe2bc16f58569dbb376c2d3ff16dfbd6

itrivediUN9UNDU64VYSOSC8PZ 0000dd41678bbf72cd61bbf241cb06ca445a6da4290565dd47321cfc5c125068

itrivediVUVF3X3TJG8IBTT 0000a8a68322f6d506747e5f0d06338125c73cf58e4eca29aac6b0930aa5175d

itrivediUZBPAIPZJRDB00CRJ 0000ce336345a5217d919f22569bb7ed0d0b14b6deb5ffb1a70c0f5c73bc6234

itrivedi02HGMKHPISUCILW 000000ae428ef1060582063e274ea64cba53820225badadc3be1c7dbd38ce073

itrivediX6SMVA5144 0000d1ff504114c5f8a6e5a862f70b3d58a6d3a5c7d203d2bc202161bea3062a

itrivedi1S0UIEU65T2SX6197 0000371d05c4f7acc25720362de6af98e121e487b33dbca9a845cf16faa3f49

itrivedi1XBI81YWMTM818F3 00002e29568c974abda9b2c67c023c7e03fa4191fff47844d0aa304bfe355ba9

itrivedi2Y3A2COOBL 0000f1615f308ca875785c24190e825ce7956f295ca6071bdbfdd3d46127dd22

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PS C:\Users\bhavy\OneDrive\Documents\FSharpPrograms> dotnet fsi Program1.fsx 4
Real: 00:00:00.000, CPU: 00:00:00.015, GC gen0: 0, gen1: 0, gen2: 0
itrivediAFK4FCP1GXS8KQWY 0000408eb69fe7714deed8e89aca39921c1e22df867ef124c0c2537b434a1ebf
itrivediFWFX5G2SA6BPEIQ9XE7 0000f212f3f36ab85071b95bd9891cc1bd86950a9eb0a6e6187044e8060f26d8
itrivediBUJUWDC64F 00009311ff71dc8c0af5ffe44e3e580a353fabe04a598ab739b8aea46ebf9473
itrivediB62KG5U5JMU 000050e5fc7088568bce22a3cae8cb9a9b3cdad922a1f27c8ac252f83ec71e8
itrivediG9041XURJGDZE4LOBBT 00002ddda625b141bdfc7207292e1a4ba1adf02d67d012dcc3a0f0723b317fcd
itrivediAVZQZUREBQR710S0UMG1 000030effca95780d77cfd7e781475456fc840066a433be198cc4d8a38e91b1
itrivediGGCRQBRYRM2TRNW8 00006d120632fb38c3ba336552307a0fcc3b94fc53e82d44135f65976c5713a3
itrivediEQQT0F29QJ 00005bd33842ea6e9f58405ffc56a07146589247577f5116abee408846beae23
itrivediEEHUZLGZKYUQVMBU38SW 00000666f535a70958f057c0f0300e2948a6cc28c834f9fcdcd2daba812692144
itrivediAL9MKEQM18D87CD0X0 0000acc5caa1ae5619eb7df568a0e255a5d6c5521052f2869048f5f0d9040d71
itrivediA5GJXAADV418LV23941B 0000dbc69cb1e588d3a0964797e1206c4e9ac9c45f8bec0a04a20b2042f011b9
itrivediA9W4FTI1VPT 00007c7bb1dd3f9fb9773191be9679fd66cbd6943d4d9dfb038a844eff4f1842
itrivediJZU3B37I6J5U 00005935951975bc3e4ce425bd16960a0781a595b0e425f9642e2b5662f9d3c0
itrivediJUZV0Q65EZL 000006ac337b1d8f00dc573a6a614875c15136f79cccd01452f8fa7b531930e0
itrivediPXEFWHEOP8A6KUC 00005985832c971f76100aa98d573579983e8464e66411913776658f2dd43434
itrivediO92RK9LN6UH2PPM7 0000836e699aadfe632eda2644943baa7aa0d15edd5c08a9b73305d31f1e3c1b
itrivediLGSYDYO71HDM7H 0000473140c66751ad72af165252bf0eb32fcfe7d43ac9d7ce44753d260413ec
itrivediMZULLONHKITEK8 00000b888e38d777545f1a8853dbe56d402d78a813efdf23d04aa6e297282e29
itrivediJ9UOCJUZ407 000067b7ddf9890fe0e06c8a4051a7e13a8beef8b8a94cf19bc6a73b239198db
itrivediINQNGMB04522JF3S0 00005e2c0f6e8a6dd223b574d38ad3f15d36888869f84796b5ca252edf8b69ac
itrivediQIC6RGNXD525P7A3FZF 0000aab487f3388a3600654cbbdc52b3a72e9e9cab56a538392d061c6abad7a6
itrivediKUAUIZVUB1F8UJX01SG 0000e601b867fb42b561581e343fe1542398b90572edf7d901be19b98883da4f
itrivediJ2GQDX938YC0TPW0XE 00004bd4e43f6d456c5056118b7ccf934877b53768355e3b4c5c0d560e5b5f2b
itrivediLYCUOQ4WBNRQU0ERUZG3 00005e976a51ae5750beec3906ae84b833272e8faf43bf102f95e57503459da1
itrivediJ5VQRGU00QG73AIW 00001004ce2e41bcb0e5c1cec6d931786715b0f185325fa71063eecedba6f3b7
itrivediN5RCKAZ2R9B 00002769f389190ef70f86735bb52b85719a11c54fad2402179e99570b21b704
itrivediV531H89P090J5Y2B4I 00003f6d2b8aaf31dc6ab5d7d989b2e8343b68dd56e2438df4257d7164d6faaf
itrivediVXSXAWIGT54CSB18J8 00004ce70d35782de2c34d93aa546a9adf5cb95cca9e49832e803d3945a60ea7
itrivediSXAT0P4E7WV 0000829e5ee20673fbecd53d7c99d944b6c7d6645aca1940664159e777d713ab
itrivediWYZUSZKNG9EP 00004953484ee899d6d987d0a86b4ecc26f1e18b496ec675ce2142603a9dae30
itrivediRKS0402R0IBOR3V0WL2 00005e4d104f7dcff183406dc65d4916c16e780d92e00c4b28dc3f1134541ef7
itrivediTHI6AZE2YUFDPE1 0000b017cac59b2c11d093554d7c3fc11310f0d75327fa280aa7d2fee059d99
itrivediTBUWF7GLIG4AEI 000041d881dec4049ed94f31355db45a389f7efb3532e253169edef94d934d40
itrivediYJAGX83CDQ 0000440ca2ddcdf3ba4fa5b5e75e2366e05c0047ac677fb24cd3080e2b832b74
itrivediT986JUTT9HUFWRHF 00008bc8077e654b7cc2cf4ed26a8ac1bc38a1619ed739164040973c3fbfc0580
itrivediSUNKI6GKISMFAW0 0000ed8411e7fd5023673d7360e1d1b8106b2e6a8799898b0e5fe70f1cc52ff7
itrivediYE6URMNAU4EFB 0000174bd93b6015463f42cb14b9ce39bf4cd3f64a495a9ee64ff8942d2ae5f6
itrivediYUAXTHN6TWNGJRR6S 00003940a03d3f4f8cc70d17241a6cc47999103555da87d4a026d2964a9787f9
itrivediWR1UUMDHZQ9RZ1 000003ebce49ac6997b1157c420a27c8d24503073d61ec4a753ea35f092dab93
itrivediYVGS103TRZ44UMMV40 0000a56beb3959c8a9335abaede2c91a37db47ede1ed3178ba205f454ee8791a
itrivediVU736TUK5T8 0000f75e5f907e1b5642752a5c88ea853a85171394f90b6c443db3c145c31948
itrivediUSSWY23W03UJNDZFXDL 00004a4e5b7a6f0ad7a8dac2adc7b53fe2bc16f58569dbb376c2d3ff16dfbd6

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itrivediUN9UNDU64VYSOSC8PZ 0000dd41678bbf72cd61bbf241cb06ca445a6da4290565dd47321cfc5c125068
itrivediVUVF3X3TJG8IBTT 0000a8a68322f6d506747e5f0d06338125c73cf58e4eca29aac6b0930aa5175d
itrivediUZBPAIPZJRDB00CRJ 0000ce336345a5217d919f22569bb7ed0d0b14b6deb5ffba70c0f5c73bc6234
itrivedi02HGMKHPISUCILW 000000ae428ef1060582063e274ea64cba53820225badadc3be1c7dbd38ce073
itrivediX6SMA5144 0000d1ff504114c5f8a6e5a862f70b3d58a6d3a5c7d203d2bc202161bea3062a
itrivedi1S0UIEU65T2SX6197 0000371d05c4f7accc25720362de6af98e121e487b33dbca9a845cf16faa3f49
itrivedi1XBI81YWTM818F3 00002e29568c974abda9b2c67c023c7e03fa4191ffff47844d0aa304bfe355ba9
itrivedi2Y3A2CO0BL 0000f1615f308ca875785c24190e825ce7956f295ca6071bdbfdd3d46127dd22
Real: 00:00:09.723, CPU: 00:00:37.765, GC gen0: 2745, gen1: 5, gen2: 0

```

Real time: 00:00:09.723s

CPU time: 00:00:37.765s

Ratio CPU/ Real time = [37.765/9.723] = **3.884**

Result of running dotnet fsi Program1.fsx 5

```
itrivediAHV9EVS8D5D4BMT 00000dc47cf42de8cba09407b383cf2ef86f39f0309003c5646f47929b2bb2a7
itrivediE8WM9Y7DD4ZBMLBYFMM 00000f9313c0e1b1f7c1bea97e14116caa27d06a4594f1f7df343aa75716324e
itrivediO7K7CCDBQJPRCVW85 00000163e5a421c307544f71536ac3504283cc2bfb6a4df87d78ae289b5222b9
itrivediUS0MSU8ZTW4E1 00000fafcb9390b6b29e1363a60a9a9934a6491a8ac37c5be92bf0dbaa42e5a5
itrivedi0H3Y0BIY4BETUDCQ 00000130d3cff8241d0762f9693e6da397289c7cc222c6d55933820d337088ce
```

```
PS C:\Users\bhavy\OneDrive\Documents\FSharpPrograms> dotnet fsi Program1.fsx 5
Real: 00:00:00.000, CPU: 00:00:00.000, GC gen0: 0, gen1: 0, gen2: 0
itrivediAHV9EVS8D5D4BMT 00000dc47cf42de8cba09407b383cf2ef86f39f0309003c5646f47929b2bb2a7
itrivediE8WM9Y7DD4ZBMLBYFMM 00000f9313c0e1b1f7c1bea97e14116caa27d06a4594f1f7df343aa75716324e
itrivediO7K7CCDBQJPRCVW85 00000163e5a421c307544f71536ac3504283cc2bfb6a4df87d78ae289b5222b9
itrivediUS0MSU8ZTW4E1 00000fafcb9390b6b29e1363a60a9a9934a6491a8ac37c5be92bf0dbaa42e5a5
itrivedi0H3Y0BIY4BETUDCQ 00000130d3cff8241d0762f9693e6da397289c7cc222c6d55933820d337088ce
Real: 00:00:11.763, CPU: 00:00:42.859, GC gen0: 2747, gen1: 4, gen2: 0
```

Real time: 00:00:11.763s

CPU time: 00:00:42.859s

Ratio CPU/ Real time = $[42.859/11.673] = 3.671$

We changed the worker size from 30 to 100 and ran the following program as for generating 6 leading zeroes we needed more workers. The maximum no of leading zeros for which we were able to efficiently mine bitcoins was 6.

Result of running dotnet fsi Program1.fsx 6

```
itrivediSOA4MLWV9KRS 0000009c46cda64908c37a0d4fccb04c78a291e178578b58672c59ebe84fecc1
```

```
PS C:\Users\bhavy\OneDrive\Documents\FSharpPrograms> dotnet fsi Program1.fsx 6
Real: 00:00:00.000, CPU: 00:00:00.015, GC gen0: 0, gen1: 0, gen2: 0
itrivediSOA4MLWV9KRS 0000009c46cda64908c37a0d4fccb04c78a291e178578b58672c59ebe84fecc1
Real: 00:01:19.020, CPU: 00:02:46.875, GC gen0: 9168, gen1: 21, gen2: 1
```

Real time: 00:01:19.020s

CPU time: 00:02:46.875s

Ratio CPU/ Real time = $[166.875/79.020] = 2.111$

Following were our observations –

- Size of the work unit that determined results in the best performance for our implementation was one in which every worker was equally generating unique and random

strings in the unit of 100000. When we divided the work among 30 child actors where each actor got a work of 100000 unit, we got best performance ie the ratio of CPU time to Real time which was **3.884** while generating bitcoins with 4 leading zeroes.

- The result of running our program for input 4 was 50 bitcoins.
- The running time for input 4 was

Real time: 00:00:09.723s

CPU time: 00:00:37.765s

Ratio CPU/ Real time i.e. Cores used = $[37.765/9.723] = \mathbf{3.884}$

- The coin with the most 0s we managed to find had **6** leading zeroes and its ratio of CPU to Real time was 2.111
- The largest number of working machines we were able to run our code with was 1.