### **Result in CS machine**

**[ziqi1756@csa1 Assignment-1-Matrix-Multiplication]$ python3 multiprocessing\_matrix\_multiplication.py**

matrix size: 1

brute forcing...

brute force running time: 1.430511474609375e-05

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multiprocessing running time: 0.017744779586791992

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 1

multiprocessing running time: 0.004422187805175781

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 1

multiprocessing running time: 0.004401683807373047

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 1

multiprocessing running time: 0.00426030158996582

validating the result...

True

summary

matrix size: 1

run time [(1, 0.017744779586791992), (1, 0.004422187805175781), (1, 0.004401683807373047), (1, 0.00426030158996582)]

speed up: [1.0, 4.012669829631227, 4.031361715957101, 4.165146342828362]

efficiency: [1.0, 4.012669829631227, 4.031361715957101, 4.165146342828362]

matrix size: 2

brute forcing...

brute force running time: 1.811981201171875e-05

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multiprocessing running time: 0.004459381103515625

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multiprocessing running time: 0.006894588470458984

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multiprocessing running time: 0.008828401565551758

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 4

multiprocessing running time: 0.007523298263549805

validating the result...

True

summary

matrix size: 2

run time [(1, 0.004459381103515625), (2, 0.006894588470458984), (4, 0.008828401565551758), (4, 0.007523298263549805)]

speed up: [1.0, 0.646794384120617, 0.5051176105214832, 0.5927428299794011]

efficiency: [1.0, 0.3233971920603085, 0.1262794026303708, 0.14818570749485027]

matrix size: 4

brute forcing...

brute force running time: 3.3855438232421875e-05

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multiprocessing running time: 0.0064792633056640625

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multiprocessing running time: 0.005528926849365234

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multiprocessing running time: 0.008667230606079102

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multiprocessing running time: 0.011768817901611328

validating the result...

True

summary

matrix size: 4

run time [(1, 0.0064792633056640625), (2, 0.005528926849365234), (4, 0.008667230606079102), (8, 0.011768817901611328)]

speed up: [1.0, 1.171884432945235, 0.7475586609083157, 0.5505449536080386]

efficiency: [1.0, 0.5859422164726175, 0.18688966522707892, 0.06881811920100482]

matrix size: 8

brute forcing...

brute force running time: 0.00013494491577148438

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multiprocessing running time: 0.006957054138183594

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multiprocessing running time: 0.006610870361328125

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multiprocessing running time: 0.008512735366821289

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multiprocessing running time: 0.011617660522460938

validating the result...

True

summary

matrix size: 8

run time [(1, 0.006957054138183594), (2, 0.006610870361328125), (4, 0.008512735366821289), (8, 0.011617660522460938)]

speed up: [1.0, 1.0523658395845354, 0.8172524856462681, 0.5988343457560334]

efficiency: [1.0, 0.5261829197922677, 0.20431312141156702, 0.07485429321950418]

matrix size: 16

brute forcing...

brute force running time: 0.0008380413055419922

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multiprocessing running time: 0.021717548370361328

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multiprocessing running time: 0.015778064727783203

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multiprocessing running time: 0.015370607376098633

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multiprocessing running time: 0.01767134666442871

validating the result...

True

summary

matrix size: 16

run time [(1, 0.021717548370361328), (2, 0.015778064727783203), (4, 0.015370607376098633), (8, 0.01767134666442871)]

speed up: [1.0, 1.3764393000695094, 1.4129271432781647, 1.228969629919454]

efficiency: [1.0, 0.6882196500347547, 0.3532317858195412, 0.15362120373993174]

matrix size: 32

brute forcing...

brute force running time: 0.005939483642578125

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multiprocessing running time: 0.13787364959716797

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multiprocessing running time: 0.08051490783691406

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multiprocessing running time: 0.09130048751831055

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multiprocessing running time: 0.20778179168701172

validating the result...

True

summary

matrix size: 32

run time [(1, 0.13787364959716797), (2, 0.08051490783691406), (4, 0.09130048751831055), (8, 0.20778179168701172)]

speed up: [1.0, 1.7123990239973468, 1.510108580411655, 0.6635502008032128]

efficiency: [1.0, 0.8561995119986734, 0.37752714510291374, 0.0829437751004016]

matrix size: 64

brute forcing...

brute force running time: 0.04588794708251953

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multiprocessing running time: 1.0575041770935059

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multiprocessing running time: 0.6256117820739746

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multiprocessing running time: 0.641352653503418

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multiprocessing running time: 2.2767128944396973

validating the result...

True

summary

matrix size: 64

run time [(1, 1.0575041770935059), (2, 0.6256117820739746), (4, 0.641352653503418), (8, 2.2767128944396973)]

speed up: [1.0, 1.690352079987622, 1.6488653649701788, 0.46448727886427654]

efficiency: [1.0, 0.845176039993811, 0.4122163412425447, 0.05806090985803457]

matrix size: 128

brute forcing...

brute force running time: 0.374253511428833

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multiprocessing running time: 8.01627516746521

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multiprocessing running time: 4.656193733215332

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multiprocessing running time: 4.890866279602051

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multiprocessing running time: 19.20838475227356

validating the result...

True

summary

matrix size: 128

run time [(1, 8.01627516746521), (2, 4.656193733215332), (4, 4.890866279602051), (8, 19.20838475227356)]

speed up: [1.0, 1.7216369478530216, 1.639029715635051, 0.41733208027897195]

efficiency: [1.0, 0.8608184739265108, 0.40975742890876277, 0.052166510034871494]

**[ziqi1756@csa1 Assignment-1-Matrix-Multiplication]$ python3 multithreading\_matrix\_multiplication.py**

matrix size: 1

brute forcing...

brute force running time: 1.5020370483398438e-05

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 0.0003075599670410156

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 0.0003829002380371094

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 0.00019741058349609375

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 0.00015497207641601562

validating the result...

True

summary

matrix size: 1

run time [(1, 0.0003075599670410156), (1, 0.0003829002380371094), (1, 0.00019741058349609375), (1, 0.00015497207641601562)]

speed up: [1.0, 0.8032378580323786, 1.5579710144927537, 1.9846153846153847]

efficiency: [1.0, 0.8032378580323786, 1.5579710144927537, 1.9846153846153847]

matrix size: 2

brute forcing...

brute force running time: 1.2636184692382812e-05

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 0.0001537799835205078

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multithreading running time: 0.00027108192443847656

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multithreading running time: 0.00048542022705078125

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 4

multithreading running time: 0.0005099773406982422

validating the result...

True

summary

matrix size: 2

run time [(1, 0.0001537799835205078), (2, 0.00027108192443847656), (4, 0.00048542022705078125), (4, 0.0005099773406982422)]

speed up: [1.0, 0.5672823218997362, 0.31679764243614933, 0.3015427769985975]

efficiency: [1.0, 0.2836411609498681, 0.07919941060903733, 0.07538569424964937]

matrix size: 4

brute forcing...

brute force running time: 2.7418136596679688e-05

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 0.00022554397583007812

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multithreading running time: 0.0002799034118652344

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multithreading running time: 0.0005431175231933594

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multithreading running time: 0.0010445117950439453

validating the result...

True

summary

matrix size: 4

run time [(1, 0.00022554397583007812), (2, 0.0002799034118652344), (4, 0.0005431175231933594), (8, 0.0010445117950439453)]

speed up: [1.0, 0.8057921635434412, 0.41527655838454786, 0.21593243551700525]

efficiency: [1.0, 0.4028960817717206, 0.10381913959613696, 0.026991554439625656]

matrix size: 8

brute forcing...

brute force running time: 0.00012540817260742188

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 0.0003917217254638672

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multithreading running time: 0.0005478858947753906

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multithreading running time: 0.0007524490356445312

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multithreading running time: 0.0011439323425292969

validating the result...

True

summary

matrix size: 8

run time [(1, 0.0003917217254638672), (2, 0.0005478858947753906), (4, 0.0007524490356445312), (8, 0.0011439323425292969)]

speed up: [1.0, 0.7149695387293299, 0.520595690747782, 0.34243434764485203]

efficiency: [1.0, 0.35748476936466494, 0.1301489226869455, 0.042804293455606504]

matrix size: 16

brute forcing...

brute force running time: 0.0008182525634765625

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 0.001971006393432617

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multithreading running time: 0.002070903778076172

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multithreading running time: 0.002244710922241211

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multithreading running time: 0.002809286117553711

validating the result...

True

summary

matrix size: 16

run time [(1, 0.001971006393432617), (2, 0.002070903778076172), (4, 0.002244710922241211), (8, 0.002809286117553711)]

speed up: [1.0, 0.951761455215289, 0.8780669144981412, 0.7016040057710261]

efficiency: [1.0, 0.4758807276076445, 0.2195167286245353, 0.08770050072137826]

matrix size: 32

brute forcing...

brute force running time: 0.006018400192260742

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 0.015001296997070312

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multithreading running time: 0.014823198318481445

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multithreading running time: 0.013681411743164062

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multithreading running time: 0.015772581100463867

validating the result...

True

summary

matrix size: 32

run time [(1, 0.015001296997070312), (2, 0.014823198318481445), (4, 0.013681411743164062), (8, 0.015772581100463867)]

speed up: [1.0, 1.012014861756711, 1.096472884427715, 0.9510996901216839]

efficiency: [1.0, 0.5060074308783555, 0.27411822110692874, 0.11888746126521049]

matrix size: 64

brute forcing...

brute force running time: 0.047434329986572266

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 0.13367486000061035

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multithreading running time: 0.12688231468200684

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multithreading running time: 0.1212308406829834

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multithreading running time: 0.11884856224060059

validating the result...

True

summary

matrix size: 64

run time [(1, 0.13367486000061035), (2, 0.12688231468200684), (4, 0.1212308406829834), (8, 0.11884856224060059)]

speed up: [1.0, 1.0535342166134583, 1.1026473069684293, 1.124749491962679]

efficiency: [1.0, 0.5267671083067291, 0.2756618267421073, 0.14059368649533488]

matrix size: 128

brute forcing...

brute force running time: 0.36438798904418945

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 1.0173559188842773

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multithreading running time: 1.0700581073760986

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multithreading running time: 1.070342779159546

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multithreading running time: 1.0676295757293701

validating the result...

True

summary

matrix size: 128

run time [(1, 1.0173559188842773), (2, 1.0700581073760986), (4, 1.070342779159546), (8, 1.0676295757293701)]

speed up: [1.0, 0.9507482928931281, 0.9504954288411467, 0.9529109552714036]

efficiency: [1.0, 0.47537414644656406, 0.23762385721028667, 0.11911386940892545]

matrix size: 256

brute forcing...

brute force running time: 3.193373441696167

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 8.49372148513794

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multithreading running time: 9.12512731552124

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multithreading running time: 9.262306928634644

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multithreading running time: 8.990013122558594

validating the result...

True

summary

matrix size: 256

run time [(1, 8.49372148513794), (2, 9.12512731552124), (4, 9.262306928634644), (8, 8.990013122558594)]

speed up: [1.0, 0.9308058059300366, 0.9170200847997594, 0.9447952265858977]

efficiency: [1.0, 0.4654029029650183, 0.22925502119993985, 0.1180994033232372]

matrix size: 512

brute forcing...

brute force running time: 37.5497841835022

number of processors: 1

parallel matrix multiplication...

actual number of processors: 1

multithreading running time: 79.369961977005

validating the result...

True

number of processors: 2

parallel matrix multiplication...

actual number of processors: 2

multithreading running time: 80.47326278686523

validating the result...

True

number of processors: 4

parallel matrix multiplication...

actual number of processors: 4

multithreading running time: 83.42097020149231

validating the result...

True

number of processors: 8

parallel matrix multiplication...

actual number of processors: 8

multithreading running time: 83.41899728775024

validating the result...

True

summary

matrix size: 512

run time [(1, 79.369961977005), (2, 80.47326278686523), (4, 83.42097020149231), (8, 83.41899728775024)]

speed up: [1.0, 0.9862898461967133, 0.9514389701450051, 0.9514614722977517]

efficiency: [1.0, 0.49314492309835667, 0.23785974253625128, 0.11893268403721896]