

## Split CPU:

```
Epoch 455 time 0.39210420330300400
Epoch 456 time 0.4204139709472656
Epoch 457 time 0.39821958541870117
Epoch 458 time 0.4023566246032715
Epoch 459 time 0.4324684143066406
Epoch 460 time 0.40221714973449707
Epoch 460 loss 0.09147290733297479 correct 50
Epoch 461 time 0.415447473526001
Epoch 462 time 0.42119860649108887
Epoch 463 time 0.4020681381225586
Epoch 464 time 0.4245109558105469
Epoch 465 time 0.4385490417480469
Epoch 466 time 0.4172956943511963
Epoch 467 time 0.40198612213134766
Epoch 468 time 0.39734864234924316
```

```
Epoch 469 time 0.4041931629180908
Epoch 470 time 0.39864540100097656
Epoch 470 loss 0.15990344668556924 correct 50
Epoch 471 time 0.41994261741638184
Epoch 472 time 0.3974878787994385
Epoch 473 time 0.408038854598999
Epoch 474 time 0.40125346183776855
Epoch 475 time 0.4180443286895752
Epoch 476 time 0.4179565906524658
Epoch 477 time 0.4006936550140381
Epoch 478 time 0.408463716506958
Epoch 479 time 0.41329026222229004
Epoch 480 time 0.39324474334716797
Epoch 480 loss 1.0224424974843453 correct 50
Epoch 481 time 0.40958356857299805
Epoch 482 time 0.39972400665283203
Epoch 483 time 0.3954942226409912
Epoch 484 time 0.40271949768066406
Epoch 485 time 0.3934745788574219
Epoch 486 time 0.41135549545288086
Epoch 487 time 0.4040350914001465
Epoch 488 time 0.4026172161102295
Epoch 489 time 0.4235196113586426
Epoch 490 time 0.3994736671447754
Epoch 490 loss 0.1156587624472133 correct 49
Epoch 491 time 0.409534215927124
Epoch 492 time 0.3994452953338623
Epoch 493 time 0.4013698101043701
Epoch 494 time 0.41077566146850586
Epoch 495 time 0.3962414264678955
Epoch 496 time 0.40471434593200684
Epoch 497 time 0.4029965400695801
Epoch 498 time 0.392120361328125
Epoch 499 time 0.41669249534606934
Average time per epoch 0.5458272099494934 (for 500 epochs)
```

### Split GPU:

```

Epoch 448 time 2.337427854537964
Epoch 449 time 2.309936285018921
Epoch 450 time 2.369734764099121
Epoch 450 loss 1.0882055610354313 correct 50
Epoch 451 time 2.335768699645996
Epoch 452 time 2.9282917976379395
Epoch 453 time 3.829131841659546
Epoch 454 time 3.9533066749572754
Epoch 455 time 2.2987027168273926
Epoch 456 time 2.2884139619293213
Epoch 457 time 2.3238632678985596
Epoch 458 time 2.2931745052337646
Epoch 459 time 2.294600486755371
Epoch 460 time 2.3326950073242188
Epoch 460 loss 0.0866319372780377 correct 50
Epoch 461 time 2.3290252685546875
Epoch 462 time 2.284113645553589
Epoch 463 time 2.35496187210083
Epoch 464 time 2.277708053588867
Epoch 465 time 2.2829034328460693
Epoch 466 time 2.5546720027923584
Epoch 467 time 3.622992753982544
Epoch 468 time 3.847134590148926
Epoch 469 time 3.933520555496216
Epoch 470 time 2.4711105823516846
Epoch 470 loss 0.4175197600621148 correct 50
Epoch 471 time 2.2956149578094482
Epoch 472 time 2.3998022079467773
Epoch 473 time 2.2927021980285645
Epoch 474 time 2.2923331260681152
Epoch 475 time 2.3086960315704346
Epoch 476 time 2.3673784732818604
Epoch 477 time 2.2882461547851562
Epoch 478 time 2.2785258293151855
Epoch 479 time 2.3401296138763428
Epoch 480 time 2.2905497550964355
Epoch 480 loss 0.1054685285965202 correct 50
Epoch 481 time 2.2735280990600586
Epoch 482 time 2.339266777038574
Epoch 483 time 2.2569456100463867
Epoch 484 time 2.268446445465088
Epoch 485 time 2.368781089782715
Epoch 486 time 2.2769908905029297
Epoch 487 time 2.26310133934021
Epoch 488 time 2.3343007564544678
Epoch 489 time 2.2727792263031006
Epoch 490 time 2.2724783420562744
Epoch 490 loss 0.04375482643731376 correct 49
Epoch 491 time 2.3252382278442383
Epoch 492 time 2.2524619102478027
Epoch 493 time 2.2599005699157715
Epoch 494 time 2.3166868686676025
Epoch 495 time 2.289226531982422
Epoch 496 time 2.7213761806488037
Epoch 497 time 3.9414429664611816
Epoch 498 time 3.879491090774536
Epoch 499 time 3.5356595516204834
Average time per epoch 2.6028382806777954 (for 500 epochs)

```

## Simple GPU:

Step 6. Run the training command

```
led $DIR; PYTHONPATH=/content/$DIR python3.8 project/run_fast_tensor.py --BACKEND gpu --HIDDEN 100 --DATASET simple --RATE 0.05
```

Epoch	258	time	2.3212220668792725	
Epoch	259	time	2.375117540359497	
Epoch	260	time	2.3190786838531494	
Epoch	260	loss	0.05948585215568653	correct 50
Epoch	261	time	2.3258321285247803	
Epoch	262	time	2.376349687576294	
Epoch	263	time	2.3104872703552246	
Epoch	264	time	2.281761884689331	
Epoch	265	time	2.395857810974121	
Epoch	266	time	2.297161102294922	
Epoch	267	time	2.406264305114746	
Epoch	268	time	2.3545777797698975	
Epoch	269	time	2.302342653274536	
Epoch	270	time	2.2802574634552	
Epoch	270	loss	0.18556343480552287	correct 50
Epoch	271	time	2.3999879360198975	
Epoch	272	time	2.3169198036193848	
Epoch	273	time	2.291147470474243	
Epoch	274	time	2.345043182373047	
Epoch	275	time	2.312941551208496	
Epoch	276	time	2.2993648052215576	
Epoch	277	time	2.3859384059906006	
Epoch	278	time	2.3333911895751953	
Epoch	279	time	3.333301067352295	
Epoch	280	time	3.981229543685913	
Epoch	280	loss	0.004183137581382606	correct 50
Epoch	281	time	3.904597759246826	
Epoch	282	time	2.86735463142395	
Epoch	283	time	2.409071922302246	
Epoch	284	time	2.3339452743530273	
Epoch	285	time	2.341492176055908	
Epoch	286	time	2.3108131885528564	
Epoch	287	time	2.3667800426483154	
Epoch	288	time	2.294581890106201	
Epoch	289	time	2.30814528465271	
Epoch	290	time	2.70467472076416	
Epoch	290	loss	0.012252943070659158	correct 50
Epoch	291	time	3.772578239440918	
Epoch	292	time	3.896401882171631	
Epoch	293	time	3.8712034225463867	
Epoch	294	time	2.3246216773986816	
Epoch	295	time	2.294692039489746	
Epoch	296	time	2.3424127101898193	
Epoch	297	time	2.2793991565704346	
Epoch	298	time	2.2929418087005615	
Epoch	299	time	2.3491790294647217	
Epoch	300	time	2.269404172897339	
Epoch	300	loss	0.32111521168284374	correct 50
Epoch	301	time	2.2739953994750977	
Epoch	302	time	2.384847640991211	
Epoch	303	time	2.3164877891540527	
Epoch	304	time	2.285327434539795	
Epoch	305	time	2.921621561050415	
Epoch	306	time	3.8027143478393555	
Epoch	307	time	3.831998348236084	
Epoch	308	time	3.526512384414673	
Epoch	309	time	2.3351500034332275	
Epoch	310	time	2.301532506942749	
Epoch	310	loss	0.1345231045710195	correct 50

## Simple CPU:

```
+ 代码 + 文本
5 分钟
[+] cd $DIR; PYTHONPATH=/content/$DIR python3.8 project/run_fast_tensor.py --BACKEND cpu --HIDDEN 100 --DATASET simple --RATE 0.05
Epoch 448 time 0.3929576873779297
Epoch 449 time 0.39336133003234863
Epoch 450 time 0.40018701553344727
Epoch 450 loss 0.0028579704910565336 correct 50
Epoch 451 time 0.4009377956390381
Epoch 452 time 0.4044535160064697
Epoch 453 time 0.39038944244384766
Epoch 454 time 0.3920738697052002
Epoch 455 time 0.3959825038909912
Epoch 456 time 0.3956427574157715
Epoch 457 time 0.416384220123291
Epoch 458 time 0.40598344802856445
Epoch 459 time 0.3922700881958008
Epoch 460 time 0.3988821506500244
Epoch 460 loss 0.0001729395546328244 correct 50
Epoch 461 time 0.40109992027282715
Epoch 462 time 0.4012179374694824
Epoch 463 time 0.38735342025756836
Epoch 464 time 0.4009253978729248
Epoch 465 time 0.43088507652282715
Epoch 466 time 0.4020192623138428
Epoch 467 time 0.4003760814666748
Epoch 468 time 0.3994433879852295
Epoch 469 time 0.4048593044281006
Epoch 470 time 0.40734052658081055
Epoch 470 loss 0.4436466433780445 correct 50
Epoch 471 time 0.3937959671020508
Epoch 472 time 0.41927194595336914
Epoch 473 time 0.6960034370422363
Epoch 474 time 2.293513059616089
Epoch 475 time 1.1735951900482178
Epoch 476 time 1.6543214321136475
Epoch 477 time 2.3218235969543457
Epoch 478 time 1.7844998836517334
Epoch 479 time 1.724034309387207
Epoch 480 time 0.8015141487121582
Epoch 480 loss 0.9535962697104893 correct 49
Epoch 481 time 0.3958704471588135
Epoch 482 time 0.40782737731933594
Epoch 483 time 0.4118320941925049
Epoch 484 time 0.3890855312347412
Epoch 485 time 0.40934133529663086
Epoch 486 time 0.38574886322021484
Epoch 487 time 0.41655468940734863
Epoch 488 time 0.38880062103271484
Epoch 489 time 0.39472389221191406
Epoch 490 time 0.40107226371765137
Epoch 490 loss 0.4117920558953133 correct 50
Epoch 491 time 0.38495516777038574
Epoch 492 time 0.407346248626709
Epoch 493 time 0.3996274471282959
Epoch 494 time 0.3900141716003418
Epoch 495 time 0.40575504302978516
Epoch 496 time 0.3865029811859131
Epoch 497 time 0.39077329635620117
Epoch 498 time 0.40717244148254395
Epoch 499 time 0.3954932689666748
Average time per epoch 0.5593818678855896 (for 500 epochs)
```

## XOR CPU:

```
lcd $DIR; PYTHONPATH=/content/$DIR python3.8 project/run_fast_tensor.py --BACKEND cpu --HIDDEN 100 --DATASET xor --RATE 0.05

Epoch 448 time 0.40317416191101074
Epoch 449 time 0.40114593505859375
Epoch 450 time 0.42101097106933594
Epoch 450 loss 0.1331871670480374 correct 50
Epoch 451 time 1.956317663192749
Epoch 452 time 1.615940809249878
Epoch 453 time 1.989410638809204
Epoch 454 time 1.9047245979309082
Epoch 455 time 2.694857597351074
Epoch 456 time 1.571916103363037
Epoch 457 time 0.4044454097747803
Epoch 458 time 0.38727760314941406
Epoch 459 time 0.3925032615661621
Epoch 460 time 0.4043099880218506
Epoch 460 loss 0.2010281337818906 correct 50
Epoch 461 time 0.38544440269470215
Epoch 462 time 0.4019625186920166
Epoch 463 time 0.39482855796813965
Epoch 464 time 0.39389872550964355
Epoch 465 time 0.404644250869751
Epoch 466 time 0.38849568367004395
Epoch 467 time 0.3998136520385742
Epoch 468 time 0.394362211227417
Epoch 469 time 0.3886256217956543
Epoch 470 time 0.40383005142211914
Epoch 470 loss 0.12891383937654965 correct 50
Epoch 471 time 0.3917837142944336
Epoch 472 time 0.3963010311126709
Epoch 473 time 0.3894622325897217
Epoch 474 time 0.38707900047302246
Epoch 475 time 0.41162776947021484
Epoch 476 time 0.39134716987609863
Epoch 477 time 0.3920927047729492
Epoch 478 time 0.40633273124694824
Epoch 479 time 0.38567161560058594
Epoch 480 time 0.4182577133178711
Epoch 480 loss 0.0852785597964201 correct 50
Epoch 481 time 0.38678526878356934
Epoch 482 time 0.38809919357299805
Epoch 483 time 0.40314269065856934
Epoch 484 time 0.38427138328552246
Epoch 485 time 0.4148437976837158
Epoch 486 time 0.39133191108703613
Epoch 487 time 0.3869814872741699
Epoch 488 time 0.4015207290649414
Epoch 489 time 0.390047550201416
Epoch 490 time 0.4072303771972656
Epoch 490 loss 0.1592029741613708 correct 50
Epoch 491 time 0.39644885063171387
Epoch 492 time 0.3857109546661377
Epoch 493 time 0.4034543037414551
Epoch 494 time 0.3956291675567627
Epoch 495 time 0.40450596809387207
Epoch 496 time 0.3971118927001953
Epoch 497 time 0.3879892826080322
Epoch 498 time 0.40504932403564453
Epoch 499 time 0.3889329433441162
Average time per epoch 0.5539714255332947 (for 500 epochs)
```

## XOR GPU:

```
[63] lcd $DIR; PYTHONPATH=/content/$DIR python3.8 project/run_fast_tensor.py --BACKEND gpu --HIDDEN 100 --DATASET xor --RATE 0.05
```

```
Epoch 448 time 2.353156566619873
Epoch 449 time 2.2630903720855713
Epoch 450 time 2.365598440170288
Epoch 450 loss 1.1580960199844994 correct 47
Epoch 451 time 3.723649263381958
Epoch 452 time 3.8313047885894775
Epoch 453 time 3.874603271484375
Epoch 454 time 2.5128419399261475
Epoch 455 time 2.2687203884124756
Epoch 456 time 2.273085355758667
Epoch 457 time 2.3699464797973633
Epoch 458 time 2.30912184715271
Epoch 459 time 2.2883083820343018
Epoch 460 time 2.381377696990967
Epoch 460 loss 0.534024048810586 correct 50
Epoch 461 time 2.2654919624328613
Epoch 462 time 2.2859437465667725
Epoch 463 time 2.3250532150268555
Epoch 464 time 2.2901382446289062
Epoch 465 time 2.256110429763794
Epoch 466 time 2.326446056365967
Epoch 467 time 2.2621712684631348
Epoch 468 time 2.2734181880590928
Epoch 469 time 2.318678379058838
Epoch 470 time 2.2511539459228516
Epoch 470 loss 0.026159219871002143 correct 50
Epoch 471 time 2.3240625858306885
Epoch 472 time 2.357668399810791
Epoch 473 time 2.2792091369628906
Epoch 474 time 2.248324155807495
Epoch 475 time 2.268671751022339
Epoch 476 time 2.3127620220184326
Epoch 477 time 2.247213840484619
Epoch 478 time 2.2651219367980957
Epoch 479 time 2.461282968521118
Epoch 480 time 3.555359363555908
Epoch 480 loss 0.23812897672479244 correct 49
Epoch 481 time 3.8076305389404297
Epoch 482 time 3.936161518096924
Epoch 483 time 2.4956626892089844
Epoch 484 time 2.2720141410827637
Epoch 485 time 2.3433611392974854
Epoch 486 time 2.2841436862945557
Epoch 487 time 2.267881393432617
Epoch 488 time 2.347817897796631
Epoch 489 time 3.125978708267212
Epoch 490 time 3.883183717727661
Epoch 490 loss 0.3772256823462845 correct 50
Epoch 491 time 3.9864048957824707
Epoch 492 time 3.0562336444854736
Epoch 493 time 2.3410842418670654
Epoch 494 time 2.3351399898529053
Epoch 495 time 2.288411855697632
Epoch 496 time 2.263587474822998
Epoch 497 time 2.357476234436035
Epoch 498 time 2.2548630237579346
Epoch 499 time 2.2546935081481934
Average time per epoch 2.5573054447174073 (for 500 epochs)
```

## XOR 200 CPU:

```
lcd $DIR; PYTHONPATH=/content/$DIR python3.8 project/run_fast_tensor.py --BACKEND cpu --HIDDEN 200 --DATASET xor --RATE 0.05

Epoch 448 time 1.3147923946380615
Epoch 449 time 1.3139300346374512
Epoch 450 time 1.3339505195617676
Epoch 450 loss 0.4897670966563738 correct 50
Epoch 451 time 1.3382527828216553
Epoch 452 time 1.3015015125274658
Epoch 453 time 1.3029537200927734
Epoch 454 time 1.3360679149627686
Epoch 455 time 1.300342321395874
Epoch 456 time 1.3017091751098633
Epoch 457 time 1.3127472400665283
Epoch 458 time 1.3244686126708984
Epoch 459 time 1.320451259613037
Epoch 460 time 1.3142328262329102
Epoch 460 loss 0.24151518275999637 correct 50
Epoch 461 time 1.3229255676269531
Epoch 462 time 1.3408479690551758
Epoch 463 time 1.3459093570709229
Epoch 464 time 1.331207513809204
Epoch 465 time 1.3389713764190674
Epoch 466 time 1.3298280239105225
Epoch 467 time 1.307978868484497
Epoch 468 time 1.3075776100158691
Epoch 469 time 1.3251585960388184
Epoch 470 time 1.3182263374328613
Epoch 470 loss 0.36244021482545696 correct 50
Epoch 471 time 6.345942974090576
Epoch 472 time 5.890122652053833
Epoch 473 time 1.3131401538848877
Epoch 474 time 1.3073711395263672
Epoch 475 time 1.299734354019165
Epoch 476 time 1.3387963771820068
Epoch 477 time 1.9204533100128174
Epoch 478 time 5.205894947052002
Epoch 479 time 5.261284589767456
Epoch 480 time 1.885984182357788
Epoch 480 loss 0.5542022805448227 correct 50
Epoch 481 time 1.314892292022705
Epoch 482 time 1.3767802715301514
Epoch 483 time 1.327246904373169
Epoch 484 time 1.3086423873901367
Epoch 485 time 1.3350226879119873
Epoch 486 time 1.300081491470337
Epoch 487 time 1.3014380931854248
Epoch 488 time 1.2959692478179932
Epoch 489 time 1.3008806705474854
Epoch 490 time 1.300964593887329
Epoch 490 loss 0.02404380143117136 correct 50
Epoch 491 time 1.2981140613555908
Epoch 492 time 1.3029522895812988
Epoch 493 time 1.3069722652435303
Epoch 494 time 1.3432731628417969
Epoch 495 time 1.3204426765441895
Epoch 496 time 1.2960827350616455
Epoch 497 time 1.336151361465454
Epoch 498 time 1.3048598766326904
Epoch 499 time 1.3187227249145508
Average time per epoch 1.6267372064590455 (for 500 epochs)
```

## XOR 200 GPU:

```
✓ 1cd $DIR; PYTHONPATH=/content/$DIR python3.8 project/run_fast_tensor.py --BACKEND gpu --HIDDEN 200 --DATASET xor --RATE 0.05
Epoch 448 time 3.1239397525787354
Epoch 449 time 3.675689458847046
Epoch 450 time 4.909078598022461
Epoch 450 loss 0.15553691284087195 correct 49
Epoch 451 time 4.926210641860962
Epoch 452 time 3.159715175628662
Epoch 453 time 2.995556116104126
Epoch 454 time 3.0587265491485596
Epoch 455 time 2.994743824005127
Epoch 456 time 3.0398528575897217
Epoch 457 time 3.056210994720459
Epoch 458 time 3.0174813270568848
Epoch 459 time 3.013801336288452
Epoch 460 time 3.069251298904419
Epoch 460 loss 0.250003021713808 correct 49
Epoch 461 time 2.9896812438964844
Epoch 462 time 3.006105899810791
Epoch 463 time 3.0805776119232178
Epoch 464 time 3.0422611236572266
Epoch 465 time 3.040693759918213
Epoch 466 time 3.1375768184661865
Epoch 467 time 3.034942626953125
Epoch 468 time 3.016240119934082
Epoch 469 time 3.0932881832122803
Epoch 470 time 3.0649328231811523
Epoch 470 loss 1.2177209838275793 correct 49
Epoch 471 time 4.079873561859131
Epoch 472 time 4.936675548553467
Epoch 473 time 4.57788348197937
Epoch 474 time 3.0372631549835205
Epoch 475 time 3.0082359313964844
Epoch 476 time 3.0596582889556885
Epoch 477 time 3.046379327774048
Epoch 478 time 3.099069833755493
Epoch 479 time 3.0745017528533936
Epoch 480 time 3.0081052780151367
Epoch 480 loss 0.9476967655152284 correct 49
Epoch 481 time 4.557928800582886
Epoch 482 time 4.884094476699829
Epoch 483 time 4.191876411437988
Epoch 484 time 2.9906067848205566
Epoch 485 time 3.0677571296691895
Epoch 486 time 3.046739101409912
Epoch 487 time 3.080258369445801
Epoch 488 time 3.1003167629241943
Epoch 489 time 3.025575876235962
Epoch 490 time 3.043999433517456
Epoch 490 loss 0.033404269931951856 correct 49
Epoch 491 time 3.2060353755950928
Epoch 492 time 4.821527719497681
Epoch 493 time 4.83082914352417
Epoch 494 time 3.9461679458618164
Epoch 495 time 3.0811073780059814
Epoch 496 time 3.0167412757873535
Epoch 497 time 3.3629097938537598
Epoch 498 time 4.702552795410156
Epoch 499 time 4.833821773529053
Average time per epoch 3.4133452553749084 (for 500 epochs)
```



3.4 Matrix output

```
Timing summary
Size: 64
    fast: 0.00581
    gpu: 0.00868
Size: 128
    fast: 0.02735
    gpu: 0.03194
Size: 256
    fast: 0.18203
    gpu: 0.09670
Size: 512
    fast: 1.21037
    gpu: 0.21421
Size: 1024
    fast: 10.45860
    gpu: 0.90377
```

