

CS 180 Machine Problem 2:

Artificial Intelligence

Submitted by:

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AND GATE

Learning rate: 0.001

Experiment 1:

Initial Weights: [0.006752 0.027632 0.024387]

=====

Counter: 1 to 148

LMS: 0.500000

=====

Counter: 149

LMS: 0.000000

=====

Final Weights of Perceptron: [0.154752 0.175632 0.172387]

Counter (Epochs): 149

Run Time: 750.000000 ms

Experiment 2:

Initial Weights: [0.007490 0.031940 0.031226]

=====

Counter: 1 to 144

LMS: 0.500000

=====

Counter: 145

LMS: 0.000000

=====

Final Weights of Perceptron: [0.151490 0.175940 0.175226]

Counter (Epochs): 145

Run Time: 699.000000 ms

Experiment 3:

Initial Weights: [0.007827 0.024914 0.003460]

=====

Counter: 1 to 155

LMS: 0.500000

=====

Counter: 156

LMS: 0.000000

=====

Final Weights of Perceptron: [0.162827 0.179914 0.158460]

Counter (Epochs): 156
Run Time: 723.000000 ms

Learning Rate= 0.0001

Experiment 1:

Initial Weights: [0.009280 0.023827 0.023160]

=====

Counter: 296

Weights of Perceptron: [0.038880 0.053427 0.052760]

LMS: 0.500000

=====

Counter: 592

Weights of Perceptron: [0.068480 0.083027 0.082360]

LMS: 0.500000

=====

Counter: 888

Weights of Perceptron: [0.098080 0.112627 0.111960]

LMS: 0.500000

=====

Counter: 1184

Weights of Perceptron: [0.127680 0.142227 0.141560]

LMS: 0.500000

=====

Counter: 1480

Weights of Perceptron: [0.157280 0.171827 0.171160]

LMS: 0.500000

=====

Counter: 1481

LMS: 0.000000

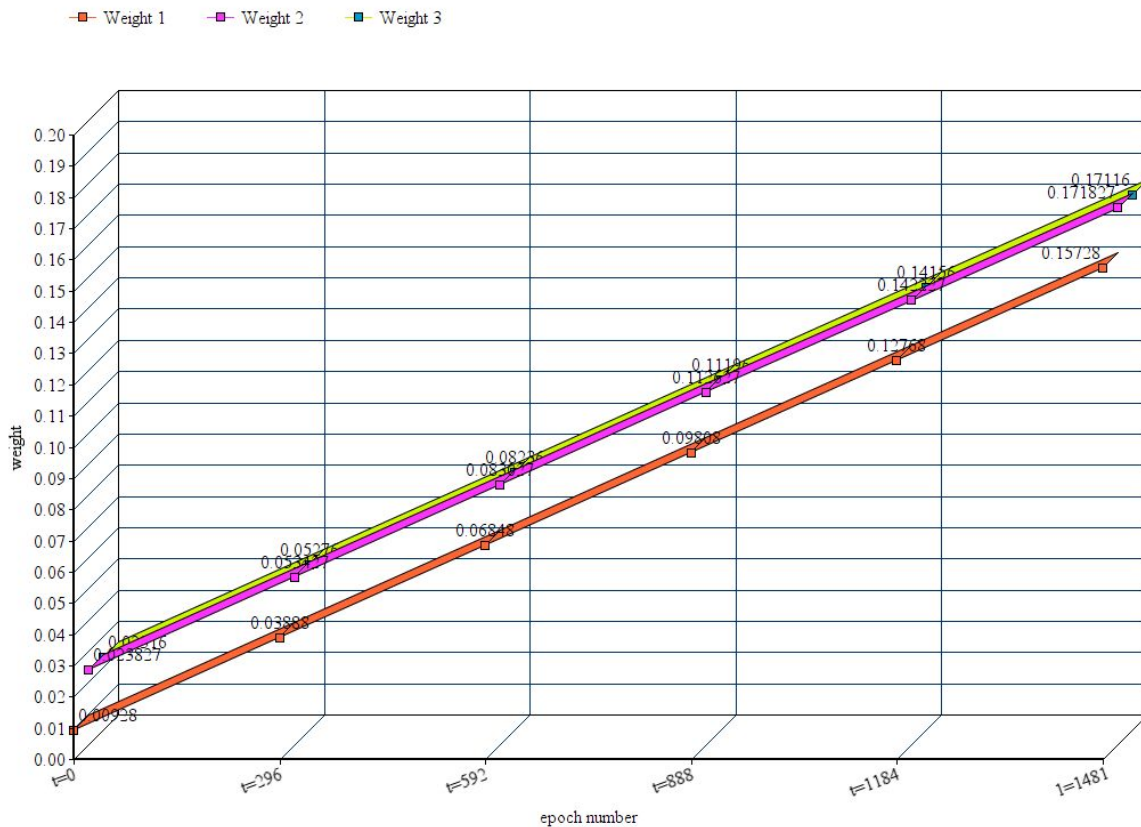
=====

Final Weights of Perceptron: [0.157280 0.171827 0.171160]

Counter (Epochs): 1481

Run Time: 9141.000000 ms

AND GATE (experiment 1)



Experiment 2:

Initial Weights: [0.014789 0.002917 0.013457]

=====

Counter: 312

Weights of Perceptron: [0.045989 0.034117 0.044657]

LMS: 0.500000

=====

Counter: 624

Weights of Perceptron: [0.077189 0.065317 0.075857]

LMS: 0.500000

=====

Counter: 936

Weights of Perceptron: [0.108389 0.096517 0.107057]

LMS: 0.500000

=====

Counter: 1248

Weights of Perceptron: [0.139589 0.127717 0.138257]

LMS: 0.500000

=====

Counter: 1560

Weights of Perceptron: [0.170789 0.158917 0.169457]

LMS: 0.500000

=====

Counter: 1564

LMS: 0.000000

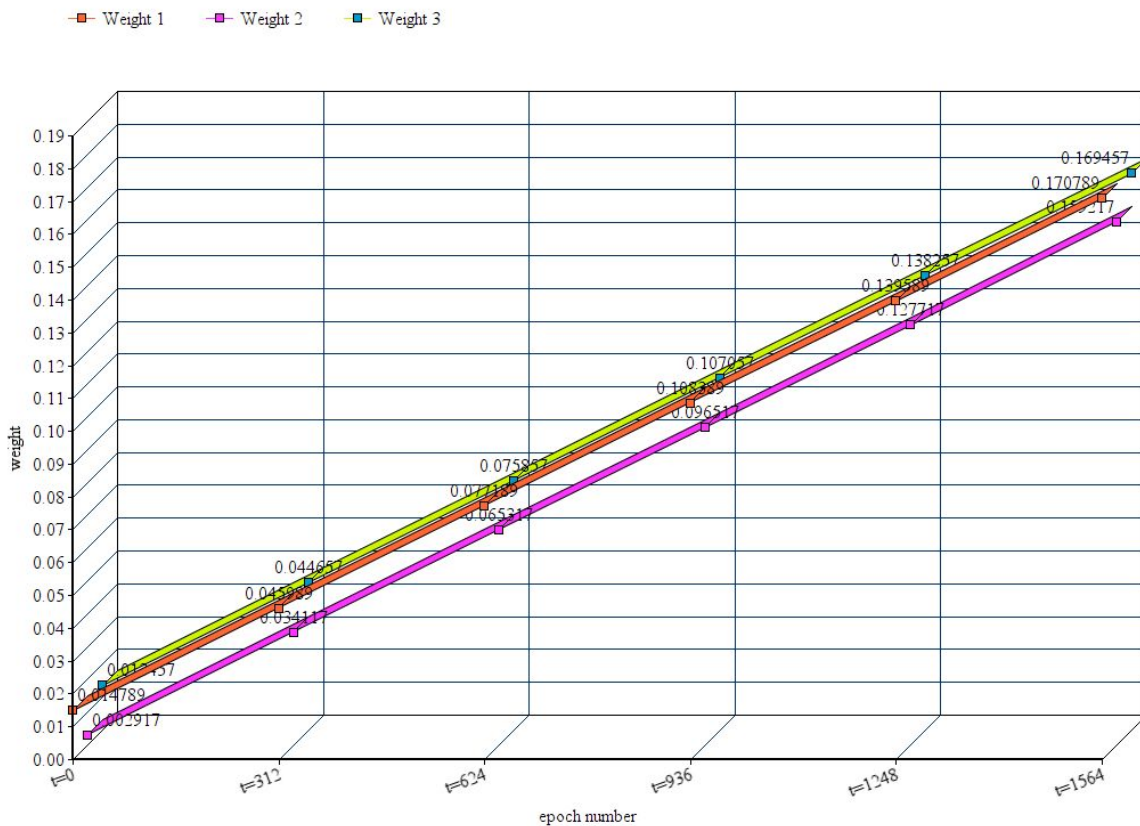
=====

Final Weights of Perceptron: [0.171089 0.159217 0.169757]

Counter (Epochs): 1564

Run Time: 9418.000000 ms

AND GATE (experiment 2)



Experiment 3:

Initial Weights: [0.017470 0.012766 0.032646]

=====

Counter: 291

Weights of Perceptron: [0.046570 0.041866 0.061746]

LMS: 0.500000

=====

Counter: 582

Weights of Perceptron: [0.075670 0.070966 0.090846]

LMS: 0.500000

=====

Counter: 873

Weights of Perceptron: [0.104770 0.100066 0.119946]

LMS: 0.500000

=====

Counter: 1164

Weights of Perceptron: [0.133870 0.129166 0.149046]

LMS: 0.500000

=====

Counter: 1455

Weights of Perceptron: [0.162970 0.158266 0.178146]

LMS: 0.500000

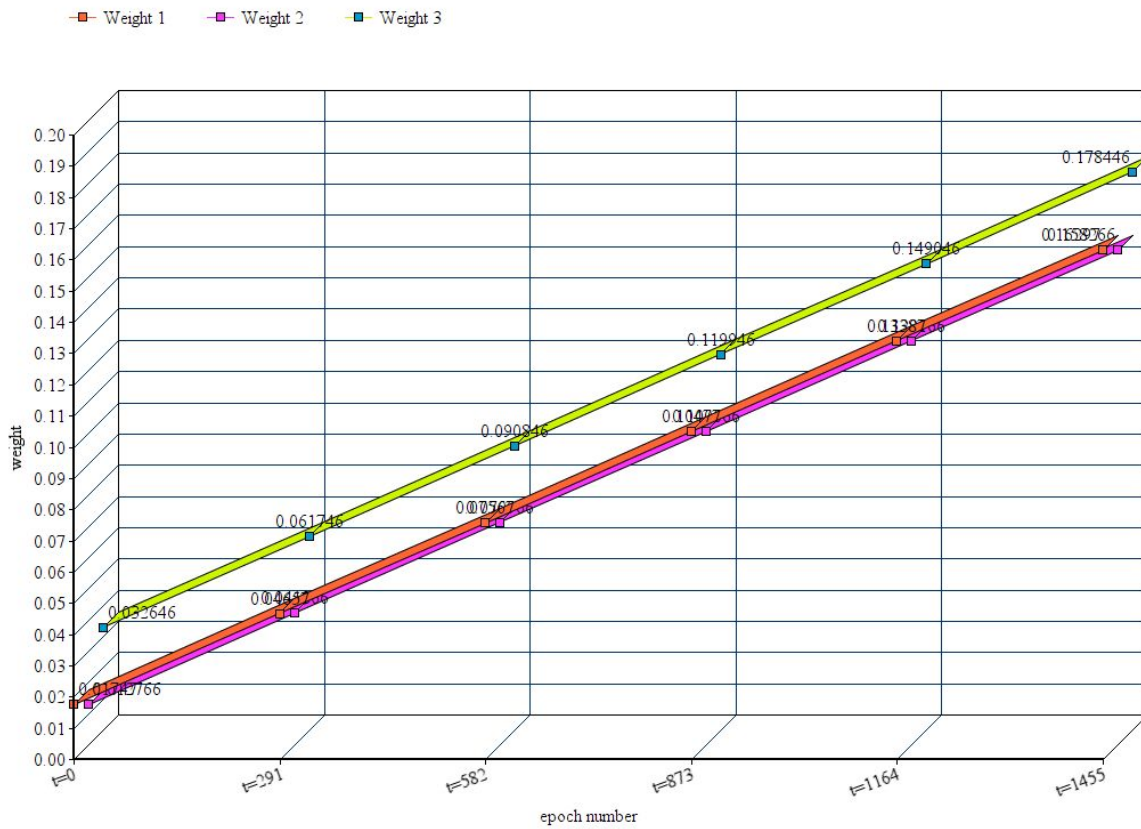
=====

Final Weights of Perceptron: [0.163270 0.158566 0.178446]

Counter (Epochs): 1459

Run Time: 8752.000000 ms

AND GATE (experiment 3)



OR GATE

Learning rate: 0.001

Experiment 1:

Initial Weights: [0.020350 0.022909 0.027437]

=====

Counter: 1 to 61

LMS: 1.500000

=====

Counter: 62 to 111

LMS: 1.000000

=====

Counter: 112

LMS: 0.500000

=====

Counter: 113

LMS: 0.000000

=====
Final Weights of Perceptron: [0.304350 0.195909 0.199437]
Counter (Epochs): 113
Run Time: 855.000000 ms

Experiment 2:

Initial Weights: [0.021953 0.024728 0.016921]

=====

Counter: 1 to 62

LMS: 1.500000

=====

Counter: 63 to 110

LMS: 1.000000

=====

Counter: 111 to 114

LMS: 0.500000

=====

Counter: 115

LMS: 0.000000

=====

Final Weights of Perceptron: [0.307953 0.196728 0.192921]

Counter (Epochs): 115

Run Time: 848.000000 ms

Experiment 3:

Initial Weights: [0.022992 0.002081 0.028864]

=====

Counter: 1 to 64

LMS: 1.500000

=====

Counter: 65 to 107

LMS: 1.000000

=====

Counter: 108 to 120

LMS: 0.500000

=====

Counter: 121

LMS: 0.000000

=====

Final Weights of Perceptron: [0.313992 0.186081 0.199864]
Counter (Epochs): 121
Run Time: 900.000000 ms

Learning rate: 0.0001

Experiment 1:

Initial Weights: [0.003482 0.026403 0.009048]

=====

Counter: 243

Weights of Perceptron: [0.076182 0.074803 0.057548]

Weights of Perceptron: [0.076282 0.074903 0.057548]

Weights of Perceptron: [0.076382 0.075003 0.057648]

LMS: 1.500000

=====

Counter: 486

Weights of Perceptron: [0.149082 0.123403 0.106148]

Weights of Perceptron: [0.149182 0.123503 0.106148]

Weights of Perceptron: [0.149282 0.123603 0.106248]

LMS: 1.500000

=====

Counter: 729

Weights of Perceptron: [0.215082 0.165103 0.147848]

Weights of Perceptron: [0.215182 0.165203 0.147848]

LMS: 1.000000

=====

Counter: 972

Weights of Perceptron: [0.263682 0.189403 0.172148]

Weights of Perceptron: [0.263782 0.189503 0.172148]

LMS: 1.000000

=====

Counter: 1215

Weights of Perceptron: [0.303682 0.205103 0.196448]

LMS: 0.500000

=====

Counter: 1216

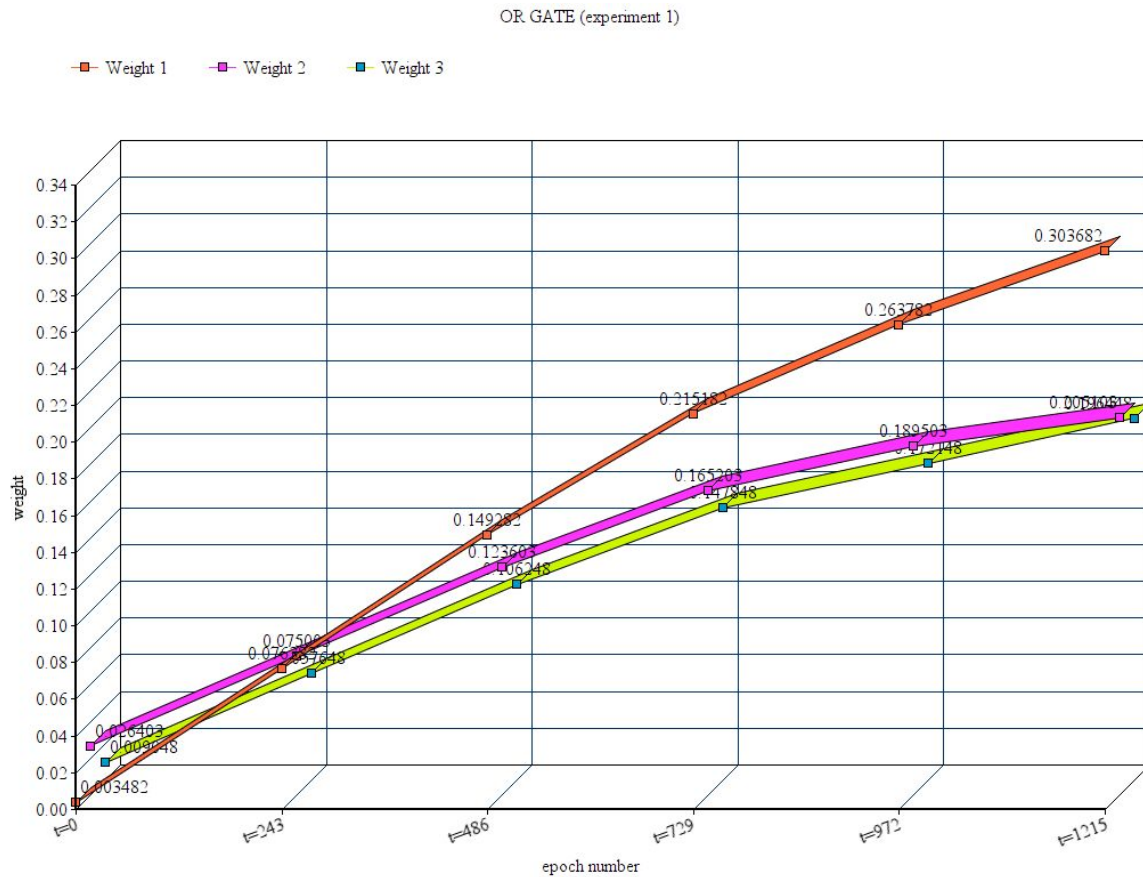
LMS: 0.000000

=====

Final Weights of Perceptron: [0.303682 0.205103 0.196448]

Counter (Epochs): 1216

Run Time: 9123.000000 ms



Experiment 2:

Initial Weights: [0.004599 0.032342 0.023747]

=====

Counter: 233

Weights of Perceptron: [0.074299 0.078742 0.070247]

Weights of Perceptron: [0.074399 0.078842 0.070247]

Weights of Perceptron: [0.074499 0.078942 0.070347]

LMS: 1.500000

=====

Counter: 466

Weights of Perceptron: [0.144199 0.125342 0.116847]

Weights of Perceptron: [0.144299 0.125442 0.116847]

Weights of Perceptron: [0.144399 0.125542 0.116947]

LMS: 1.500000

=====

Counter: 699

Weights of Perceptron: [0.207099 0.164942 0.156447]

Weights of Perceptron: [0.207199 0.165042 0.156447]

LMS: 1.000000

=====

Counter: 932

Weights of Perceptron: [0.253699 0.188242 0.179747]

Weights of Perceptron: [0.253799 0.188342 0.179747]

LMS: 1.000000

=====

Counter: 1165

Weights of Perceptron: [0.296399 0.207642 0.203047]

LMS: 0.500000

=====

Counter: 1169

LMS: 0.000000

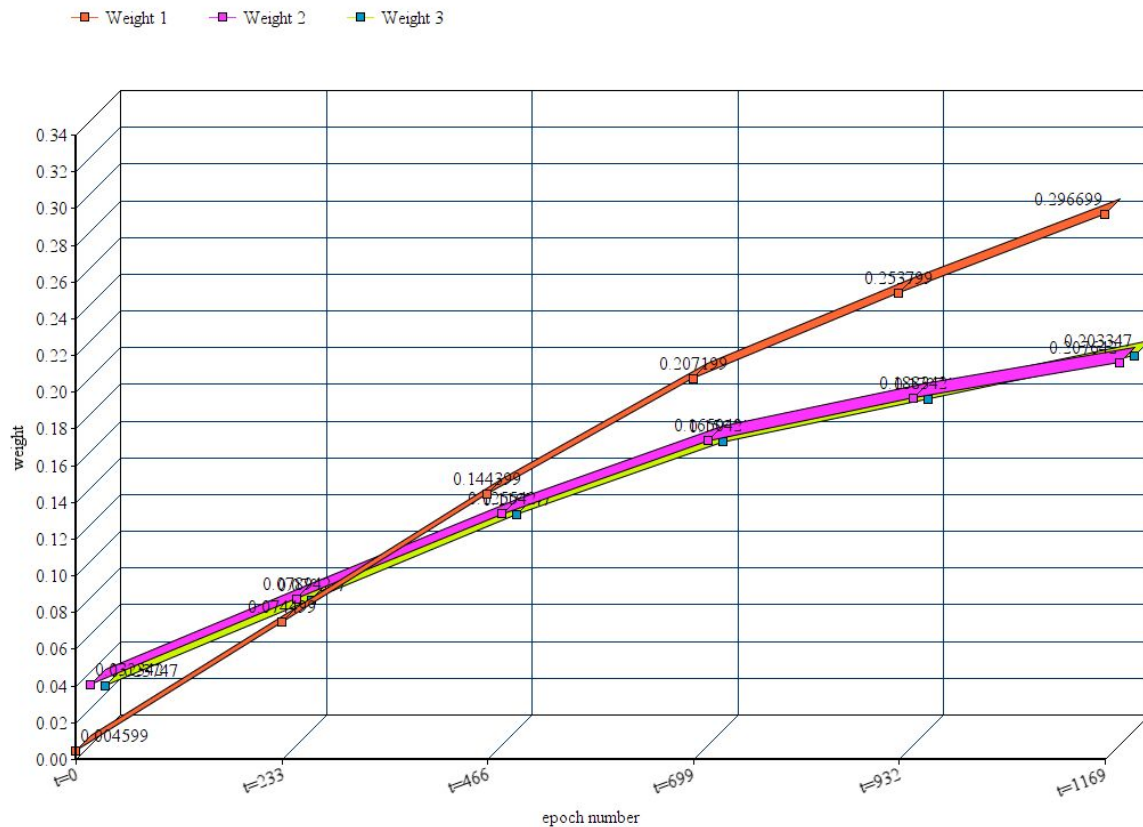
=====

Final Weights of Perceptron: [0.296699 0.207642 0.203347]

Counter (Epochs): 1169

Run Time: 8788.000000 ms

OR GATE (experiment 2)



Experiment 3:

Initial Weights: [0.005745 0.003945 0.002615]

=====

Counter: 235

Weights of Perceptron: [0.076045 0.050745 0.049515]

Weights of Perceptron: [0.076145 0.050845 0.049515]

Weights of Perceptron: [0.076245 0.050945 0.049615]

LMS: 1.500000

=====

Counter: 470

Weights of Perceptron: [0.146545 0.097745 0.096515]

Weights of Perceptron: [0.146645 0.097845 0.096515]

Weights of Perceptron: [0.146745 0.097945 0.096615]

LMS: 1.500000

=====

Counter: 705

Weights of Perceptron: [0.216345 0.144045 0.142815]

Weights of Perceptron: [0.216445 0.144145 0.142815]

LMS: 1.000000

=====

Counter: 940

Weights of Perceptron: [0.263345 0.167545 0.166315]

Weights of Perceptron: [0.263445 0.167645 0.166315]

LMS: 1.000000

=====

Counter: 1175

Weights of Perceptron: [0.309945 0.190645 0.189815]

LMS: 0.500000

=====

Counter: 1178

LMS: 0.000000

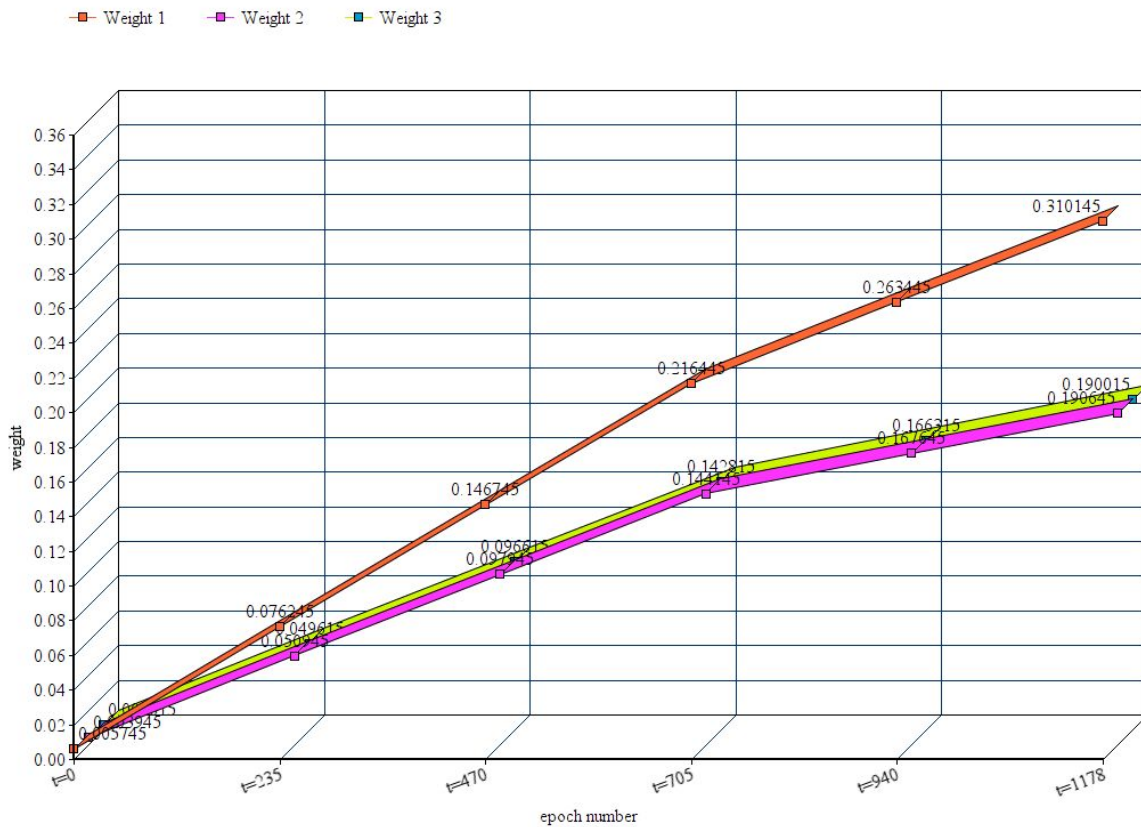
=====

Final Weights of Perceptron: [0.310145 0.190645 0.190015]

Counter (Epochs): 1178

Run Time: 9052.000000 ms

OR GATE (experiment 3)



XOR GATE

Learning rate: 0.001

Experiment 1:

Initial Weights: [0.007185 0.025400 0.016395]

=====

Counter: 1 to 112

LMS: 1.000000

=====

Counter: 113 to 243

LMS: 1.500000

=====

Counter: 244 to 263

LMS: Alternate 1.000000 and 1.500000

=====

Counter: 264 to 647

LMS: 1.000000-1.000000-1.500000

=====

Counter: 648 to 10000

LMS: 2.000000

=====

Final Weights of Perceptron: [0.500185 -0.000600 0.000395]

Counter (Epochs): 10000

Run Time: 97209.000000 ms

Experiment 2:

Initial Weights: [0.011832 0.017726 0.009143]

=====

Counter: 1 to 115

LMS: 1.000000

=====

Counter: 116 to 263

LMS: 1.500000

=====

Counter: 264 to 632

LMS: 1.000000-1.000000-1.500000

=====

Counter: 633 to 10000

LMS: 2.000000

=====

Final Weights of Perceptron: [0.500832 -0.001274 0.000143]

Counter (Epochs): 10000

Run Time: 96470.000000 ms

Experiment 3:

Initial Weights: [0.013589 0.000433 0.019043]

=====

Counter: 1 to 116

LMS: 1.000000

=====

Counter: 117 to 236

LMS: 1.500000

=====

Counter: 236 to 270

LMS: Alternate 1.000000 and 1.500000

=====

Counter: 271 to 624

LMS: 1.000000-1.000000-1.500000

=====

Counter: 624 to 10000

LMS: 2.000000

=====

Final Weights of Perceptron: [0.500589 -0.001567 0.000043]

Counter (Epochs): 10000

Run Time: 95165.000000 ms

Learning rate: 0.0001

Experiment 1:

Initial Weights: [0.004206 0.030507 0.018103]

=====

Counter: 2000

Weights of Perceptron: [0.499206 -0.000493 0.000103]

Weights of Perceptron: [0.500206 -0.000493 0.001103]

Weights of Perceptron: [0.501206 0.000507 0.001103]

Weights of Perceptron: [0.500206 -0.000493 0.000103]

LMS: 2.000000

=====

Counter: 4000

Weights of Perceptron: [0.499206 -0.000493 0.000103]

Weights of Perceptron: [0.500206 -0.000493 0.001103]

Weights of Perceptron: [0.501206 0.000507 0.001103]

Weights of Perceptron: [0.500206 -0.000493 0.000103]

LMS: 2.000000

=====

Counter: 6000

Weights of Perceptron: [0.499206 -0.000493 0.000103]

Weights of Perceptron: [0.500206 -0.000493 0.001103]

Weights of Perceptron: [0.501206 0.000507 0.001103]

Weights of Perceptron: [0.500206 -0.000493 0.000103]

LMS: 2.000000

=====

Counter: 8000

Weights of Perceptron: [0.499206 -0.000493 0.000103]

Weights of Perceptron: [0.500206 -0.000493 0.001103]

Weights of Perceptron: [0.501206 0.000507 0.001103]

Weights of Perceptron: [0.500206 -0.000493 0.000103]

LMS: 2.000000

=====

Counter: 10000

Weights of Perceptron: [0.499206 -0.000493 0.000103]

Weights of Perceptron: [0.500206 -0.000493 0.001103]

Weights of Perceptron: [0.501206 0.000507 0.001103]

Weights of Perceptron: [0.500206 -0.000493 0.000103]

LMS: 2.000000

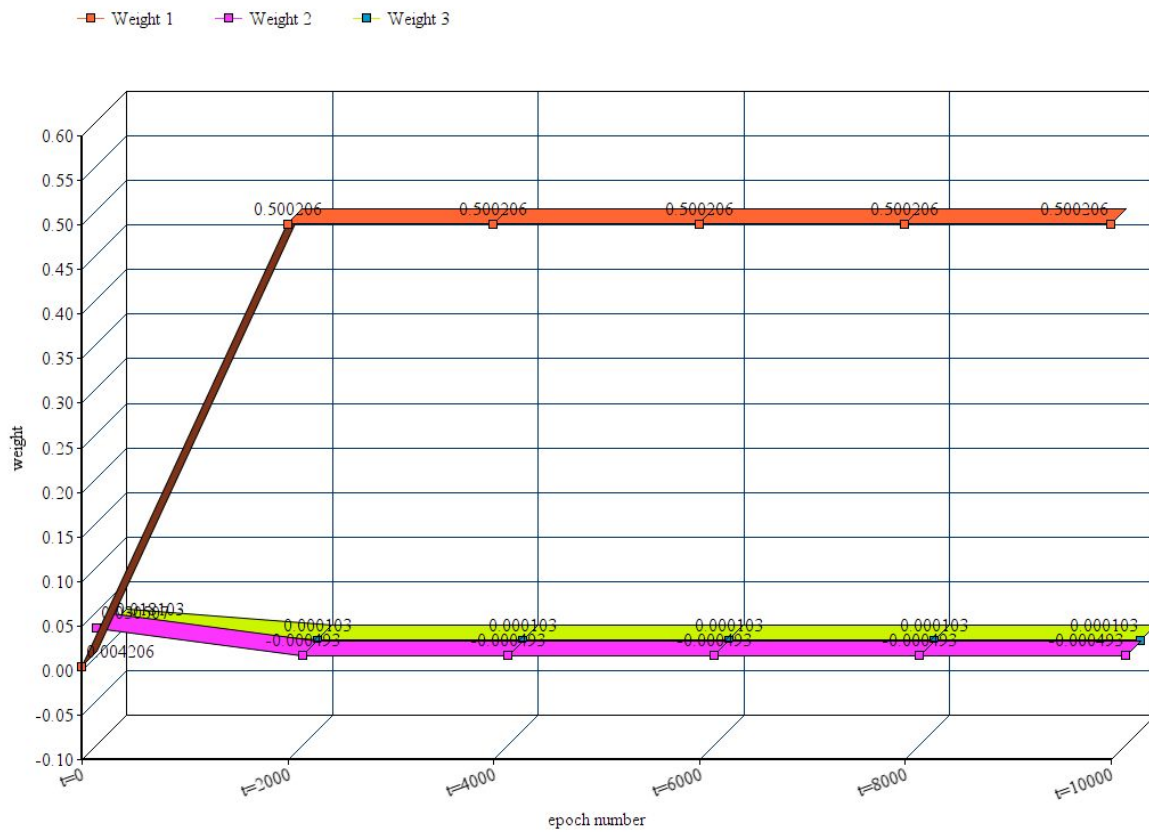
=====

Final Weights of Perceptron: [0.500206 -0.000493 0.000103]

Counter (Epochs): 10000

Run Time: 100675.000000 ms

XOR GATE (experiment 1)



Experiment 2:

Initial Weights: [0.005388 0.022038 0.029637]

=====

Counter: 2000

Weights of Perceptron: [0.499388 -0.000962 -0.000363]

Weights of Perceptron: [0.500388 -0.000962 0.000637]

Weights of Perceptron: [0.501388 0.000038 0.000637]

Weights of Perceptron: [0.500388 -0.000962 -0.000363]

LMS: 2.000000

=====

Counter: 4000

Weights of Perceptron: [0.499388 -0.000962 -0.000363]

Weights of Perceptron: [0.500388 -0.000962 0.000637]

Weights of Perceptron: [0.501388 0.000038 0.000637]

Weights of Perceptron: [0.500388 -0.000962 -0.000363]

LMS: 2.000000

=====

Counter: 6000

Weights of Perceptron: [0.499388 -0.000962 -0.000363]

Weights of Perceptron: [0.500388 -0.000962 0.000637]

Weights of Perceptron: [0.501388 0.000038 0.000637]

Weights of Perceptron: [0.500388 -0.000962 -0.000363]

LMS: 2.000000

=====

Counter: 8000

Weights of Perceptron: [0.499388 -0.000962 -0.000363]

Weights of Perceptron: [0.500388 -0.000962 0.000637]

Weights of Perceptron: [0.501388 0.000038 0.000637]

Weights of Perceptron: [0.500388 -0.000962 -0.000363]

LMS: 2.000000

=====

Counter: 10000

Weights of Perceptron: [0.499388 -0.000962 -0.000363]

Weights of Perceptron: [0.500388 -0.000962 0.000637]

Weights of Perceptron: [0.501388 0.000038 0.000637]

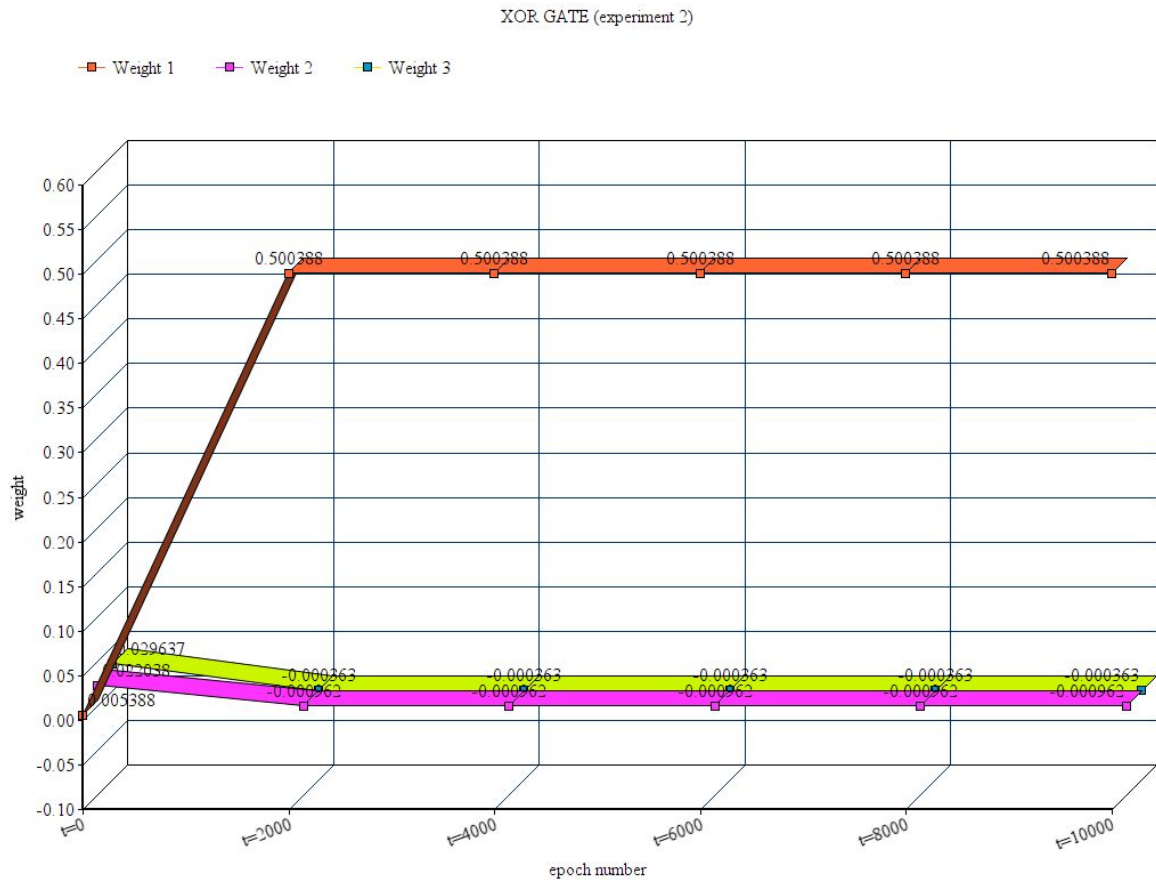
Weights of Perceptron: [0.500388 -0.000962 -0.000363]

LMS: 2.000000

=====

Final Weights of Perceptron: [0.500388 -0.000962 -0.000363]

Counter (Epochs): 10000
Run Time: 94058.000000 ms



Experiment 3:

Initial Weights: [0.006515 0.027455 0.032392]

=====

Counter: 2000

Weights of Perceptron: [0.499515 -0.000545 0.000392]

Weights of Perceptron: [0.500515 -0.000545 0.001392]

Weights of Perceptron: [0.501515 0.000455 0.001392]

Weights of Perceptron: [0.500515 -0.000545 0.000392]

LMS: 2.000000

=====

Counter: 4000

Weights of Perceptron: [0.499515 -0.000545 0.000392]

Weights of Perceptron: [0.500515 -0.000545 0.001392]

Weights of Perceptron: [0.501515 0.000455 0.001392]

Weights of Perceptron: [0.500515 -0.000545 0.000392]
LMS: 2.000000

=====

Counter: 6000

Weights of Perceptron: [0.499515 -0.000545 0.000392]
Weights of Perceptron: [0.500515 -0.000545 0.001392]
Weights of Perceptron: [0.501515 0.000455 0.001392]
Weights of Perceptron: [0.500515 -0.000545 0.000392]
LMS: 2.000000

=====

Counter: 8000

Weights of Perceptron: [0.499515 -0.000545 0.000392]
Weights of Perceptron: [0.500515 -0.000545 0.001392]
Weights of Perceptron: [0.501515 0.000455 0.001392]
Weights of Perceptron: [0.500515 -0.000545 0.000392]
LMS: 2.000000

=====

Counter: 10000

Weights of Perceptron: [0.499515 -0.000545 0.000392]
Weights of Perceptron: [0.500515 -0.000545 0.001392]
Weights of Perceptron: [0.501515 0.000455 0.001392]
Weights of Perceptron: [0.500515 -0.000545 0.000392]
LMS: 2.000000

=====

Final Weights of Perceptron: [0.500515 -0.000545 0.000392]
Counter (Epochs): 10000
Run Time: 93535.000000 ms

XOR GATE (experiment 3)

