XOR neural network sample output

```
--- Net: ---
 Net(\\
  (fc1): Linear(in_features=2, out_features=16, bias=True)
  (fc2): Linear(in_features=16, out_features=16, bias=True)
  (fc3): Linear(in_features=16, out_features=2, bias=True)
)

--- Training set: ---
 tensor([[0., 0., 1., 0.],
        [0., 1., 0., 1.],
        [1., 0., 0., 1.],
        [1., 1., 1., 0.]])

--- Testing set: ---
 tensor([[0., 0., 1., 0.],
        [0., 1., 0., 1.],
        [1., 0., 0., 1.],
        [1., 1., 1., 0.]])

--- Testing data before training... ---

--- Training now... ---
Epoch #1  loss: 0.453
Epoch #2  loss: 0.175
Epoch #3  loss: 0.203
Epoch #4  loss: 0.247
Epoch #5  loss: 0.288
Epoch #6  loss: 0.298
Epoch #7  loss: 0.264
Epoch #8  loss: 0.219
Epoch #9  loss: 0.189
Epoch #10 loss: 0.18
Epoch #11 loss: 0.183
Epoch #12 loss: 0.18
Epoch #13 loss: 0.154
Epoch #14 loss: 0.113
Epoch #15 loss: 0.078
Epoch #16 loss: 0.056
Epoch #17 loss: 0.018
Epoch #18 loss: 0.004

--- Testing data after training... ---

--- Plotting test results before and after... ---
```

x^2 neural network sample output

```
--- Net: ---
 Net(
  (fc1): Linear(in_features=1, out_features=4, bias=True)
  (fc2): Linear(in_features=4, out_features=16, bias=True)
  (fc3): Linear(in_features=16, out_features=16, bias=True)
  (fc4): Linear(in_features=16, out_features=1, bias=True)
)

--- Training Set: ---
 tensor([[ 4.5680e+00,  2.5745e+01,  2.0867e+01],
        [-5.2050e+00,  2.0354e+01,  2.7092e+01],
        [-9.6550e+00,  8.4205e+01,  9.3219e+01],
        [-8.0050e+00,  6.4284e+01,  6.4080e+01],
        [-5.4600e+00,  2.1445e+01,  2.9812e+01],
        [-8.9760e+00,  8.2067e+01,  8.0569e+01],
        [ 2.9600e+00,  4.5146e+00,  8.7616e+00],
        [ 4.8940e+00,  3.1543e+01,  2.3951e+01],
        [ 9.6900e-01, -8.1110e+00,  9.3896e-01],
        [-1.4090e+00,  9.4773e+00,  1.9853e+00],
        [-6.1970e+00,  3.2883e+01,  3.8403e+01],
        [-1.3320e+00, -5.8598e+00,  1.7742e+00],
        [-6.4240e+00,  4.2088e+01,  4.1268e+01],
        [-6.5560e+00,  4.8644e+01,  4.2981e+01],
        [ 6.8310e+00,  4.9639e+01,  4.6663e+01],
        [ 6.8090e+00,  5.3262e+01,  4.6362e+01],
        [-5.0140e+00,  2.5017e+01,  2.5140e+01],
        [-7.0020e+00,  4.5674e+01,  4.9028e+01],
        [ 4.3240e+00,  2.7689e+01,  1.8697e+01],
        [-3.7330e+00,  1.6052e+01,  1.3935e+01],
        [ 4.2920e+00,  1.4174e+01,  1.8421e+01],
        [-2.3570e+00, -1.7546e+00,  5.5554e+00],
        [ 3.1410e+00,  4.7869e+00,  9.8659e+00],
        [-3.6300e+00,  1.2093e+01,  1.3177e+01],
        [ 1.8760e+00,  7.7004e+00,  3.5194e+00],
        [-3.3500e-01,  8.3862e+00,  1.1223e-01],
        [-4.6360e+00,  2.1332e+01,  2.1492e+01],
        [ 6.6580e+00,  5.1139e+01,  4.4329e+01],
        [-7.3520e+00,  5.9207e+01,  5.4052e+01],
        [ 6.5020e+00,  4.6316e+01,  4.2276e+01],
        [ 1.6280e+00, -4.0366e+00,  2.6504e+00],
        [-2.1870e+00,  8.1430e+00,  4.7830e+00],
        [-2.6000e+00,  1.3084e+01,  6.7600e+00],
        [-2.3650e+00,  1.0290e+01,  5.5932e+00],
        [-9.4230e+00,  8.9538e+01,  8.8793e+01],
        [ 2.2170e+00,  6.1021e+00,  4.9151e+00],
        [ 7.8770e+00,  6.1500e+01,  6.2047e+01],
        [ 3.8230e+00,  5.8873e+00,  1.4615e+01],
        [-3.9360e+00,  1.8837e+01,  1.5492e+01],
        [-8.6700e-01, -6.3813e+00,  7.5169e-01],
        [-6.0030e+00,  2.9917e+01,  3.6036e+01],
        [ 1.2570e+00,  1.0499e+01,  1.5800e+00],
        [ 6.4130e+00,  4.5257e+01,  4.1127e+01],
        [ 1.4640e+00,  1.1723e+01,  2.1433e+00],
        [-9.1770e+00,  8.3734e+01,  8.4217e+01],
        [-6.8170e+00,  5.2834e+01,  4.6471e+01],
        [ 7.5130e+00,  4.7813e+01,  5.6445e+01],
        [ 1.7610e+00, -6.2579e+00,  3.1011e+00],
        [ 6.1100e+00,  2.8610e+01,  3.7332e+01],
        [ 6.4000e-02, -6.1219e+00,  4.0960e-03],
        [ 1.2260e+00,  4.0281e+00,  1.5031e+00],
        [-9.2210e+00,  7.9473e+01,  8.5027e+01],
        [ 4.9850e+00,  2.3583e+01,  2.4850e+01],
        [ 7.6040e+00,  5.6397e+01,  5.7821e+01],
        [-1.8050e+00,  6.6640e+00,  3.2580e+00],
        [-2.5310e+00,  8.6796e-01,  6.4060e+00],
        [-1.7530e+00,  1.0070e+01,  3.0730e+00],
        [-6.5980e+00,  3.3687e+01,  4.3534e+01],
        [-5.9890e+00,  3.7171e+01,  3.5868e+01],
        [-3.4010e+00,  1.7398e+00,  1.1567e+01],
```

```
        [ 6.8400e-01, -2.4751e+00,  4.6786e-01],
        [ 4.2250e+00,  1.1133e+01,  1.7851e+01],
        [-7.4300e+00,  5.6515e+01,  5.5205e+01],
        [ 5.1890e+00,  3.3831e+01,  2.6926e+01],
        [-9.7550e+00,  9.8195e+01,  9.5160e+01],
        [-9.7740e+00,  8.9955e+01,  9.5531e+01],
        [ 6.1190e+00,  3.7158e+01,  3.7442e+01],
        [ 4.8910e+00,  2.0757e+01,  2.3922e+01],
        [ 7.9220e+00,  6.5631e+01,  6.2758e+01],
        [ 3.4710e+00,  5.3428e+00,  1.2048e+01],
        [-2.5700e-01,  1.6510e+00,  6.6049e-02],
        [-6.8450e+00,  5.2909e+01,  4.6854e+01],
        [-1.5560e+00,  4.7861e+00,  2.4211e+00],
        [ 7.0370e+00,  5.2636e+01,  4.9519e+01],
        [-9.4800e+00,  8.3930e+01,  8.9870e+01],
        [ 3.1710e+00,  1.6089e+01,  1.0055e+01],
        [ 4.8000e-02, -9.4067e+00,  2.3040e-03],
        [-6.1390e+00,  3.3601e+01,  3.7687e+01],
        [ 4.3790e+00,  1.6309e+01,  1.9176e+01],
        [-2.5430e+00,  1.2062e+01,  6.4668e+00],
        [ 9.9800e+00,  9.6831e+01,  9.9600e+01],
        [-2.1240e+00, -1.0806e+00,  4.5114e+00],
        [ 3.1270e+00,  2.0551e+00,  9.7781e+00],
        [ 8.0660e+00,  6.0086e+01,  6.5060e+01],
        [-9.6080e+00,  8.9419e+01,  9.2314e+01],
        [-3.8950e+00,  9.0240e+00,  1.5171e+01],
        [-5.4700e+00,  3.1723e+01,  2.9921e+01],
        [ 3.8400e+00,  2.1270e+01,  1.4746e+01],
        [-8.7680e+00,  7.7110e+01,  7.6878e+01],
        [ 6.1450e+00,  3.7973e+01,  3.7761e+01],
        [-6.4160e+00,  4.1645e+01,  4.1165e+01],
        [-6.4770e+00,  4.1891e+01,  4.1952e+01],
        [ 4.7610e+00,  1.7107e+01,  2.2667e+01],
        [ 5.2300e-01,  2.1315e+00,  2.7353e-01],
        [-1.5700e-01, -2.8324e+00,  2.4649e-02],
        [-5.4250e+00,  2.0977e+01,  2.9431e+01],
        [-9.4310e+00,  8.4326e+01,  8.8944e+01],
        [-9.1490e+00,  7.7201e+01,  8.3704e+01],
        [-3.8960e+00,  5.2988e+00,  1.5179e+01],
        [ 4.3340e+00,  1.3124e+01,  1.8784e+01]])

--- Testing Set: ---
 tensor([[ -9.5580,  81.8604,  91.3554],
        [  6.2660,  48.4128,  39.2628],
        [ -4.4880,  29.3431,  20.1421],
        [  6.5400,  41.1536,  42.7716],
        [ -3.4370,  10.9670,  11.8130],
        [  3.3360,  12.7529,  11.1289],
        [ -2.4500,   1.7215,   6.0025],
        [  4.0200,  25.0464,  16.1604],
        [  1.8580,   8.1072,   3.4522],
        [  7.3110,  56.2577,  53.4507],
        [ -7.1550,  54.2660,  51.1940],
        [ -3.7030,   7.1792,  13.7122],
        [ -3.5820,  10.7837,  12.8307],
        [ -3.2530,  12.7440,  10.5820],
        [  4.5010,  11.1350,  20.2590],
        [  4.2830,  14.2571,  18.3441],
        [ -3.0450,  16.9840,   9.2720],
        [ -9.3410,  82.4973,  87.2543],
        [  0.9800,  -2.3906,   0.9604],
        [  7.5060,  54.7270,  56.3400],
        [ -5.4660,  22.1042,  29.8772],
        [  8.8860,  73.6110,  78.9610],
        [  2.5050,  14.1680,   6.2750],
        [  5.5110,  34.9281,  30.3711],
        [ -3.1140,   4.8020,   9.6970],
        [  8.1970,  67.0458,  67.1908],
        [ -8.3960,  65.3668,  70.4928],
        [ -9.8480, 105.3471,  96.9831],
        [ -1.6180,   3.5789,   2.6179],
        [ -4.7990,  22.3844,  23.0304],
```

```
        [ -3.0580,  11.2564,   9.3514],
        [  1.0440,  -1.7331,   1.0899],
        [  4.9050,  26.0560,  24.0590],
        [ -7.0560,  53.3661,  49.7871],
        [ -8.3320,  75.6162,  69.4222],
        [ -5.1580,  25.8730,  26.6050],
        [  4.4050,  20.1090,  19.4040],
        [ -6.8430,  55.2617,  46.8266],
        [  7.7160,  66.5817,  59.5367],
        [  8.3580,  68.3002,  69.8562],
        [ -7.5820,  63.3227,  57.4867],
        [ -9.8290,  91.3742,  96.6092],
        [  1.8710,   4.0296,   3.5006],
        [ -9.6350,  89.5142,  92.8332],
        [  6.3610,  36.7063,  40.4623],
        [  8.9890,  84.3911,  80.8021],
        [ -0.7590,  -5.1369,   0.5761],
        [ -7.3250,  53.5326,  53.6556],
        [ -7.8640,  71.2075,  61.8425],
        [  5.8340,  32.0336,  34.0356]])
```

```
--- Testing data before training... ---
```

x	y	x2 NN	x2 label	y vs x2 NN	y vs x2 label	correct?
-9.558	81.86	-0.673	91.355	+ (y > x2)	- (y < x2)	no
6.266	48.413	-0.515	39.263	+ (y > x2)	+ (y > x2)	yes
-4.488	29.343	-0.425	20.142	+ (y > x2)	+ (y > x2)	yes
6.54	41.154	-0.528	42.772	+ (y > x2)	- (y < x2)	no
-3.437	10.967	-0.366	11.813	+ (y > x2)	- (y < x2)	no
3.336	12.753	-0.36	11.129	+ (y > x2)	+ (y > x2)	yes
-2.45	1.722	-0.309	6.003	+ (y > x2)	- (y < x2)	no
4.02	25.046	-0.399	16.16	+ (y > x2)	+ (y > x2)	yes
1.858	8.107	-0.274	3.452	+ (y > x2)	+ (y > x2)	yes
7.311	56.258	-0.565	53.451	+ (y > x2)	+ (y > x2)	yes
-7.155	54.266	-0.557	51.194	+ (y > x2)	+ (y > x2)	yes
-3.703	7.179	-0.381	13.712	+ (y > x2)	- (y < x2)	no
-3.582	10.784	-0.374	12.831	+ (y > x2)	- (y < x2)	no
-3.253	12.744	-0.355	10.582	+ (y > x2)	+ (y > x2)	yes
4.501	11.135	-0.425	20.259	+ (y > x2)	- (y < x2)	no
4.283	14.257	-0.413	18.344	+ (y > x2)	- (y < x2)	no
-3.045	16.984	-0.343	9.272	+ (y > x2)	+ (y > x2)	yes
-9.341	82.497	-0.662	87.254	+ (y > x2)	- (y < x2)	no
0.98	-2.391	-0.218	0.96	- (y < x2)	- (y < x2)	yes
7.506	54.727	-0.574	56.34	+ (y > x2)	- (y < x2)	no
-5.466	22.104	-0.477	29.877	+ (y > x2)	- (y < x2)	no
8.886	73.611	-0.64	78.961	+ (y > x2)	- (y < x2)	no
2.505	14.168	-0.312	6.275	+ (y > x2)	+ (y > x2)	yes
5.511	34.928	-0.479	30.371	+ (y > x2)	+ (y > x2)	yes
-3.114	4.802	-0.347	9.697	+ (y > x2)	- (y < x2)	no
8.197	67.046	-0.606	67.191	+ (y > x2)	- (y < x2)	no
-8.396	65.367	-0.616	70.493	+ (y > x2)	- (y < x2)	no
-9.848	105.347	-0.687	96.983	+ (y > x2)	+ (y > x2)	yes
-1.618	3.579	-0.259	2.618	+ (y > x2)	+ (y > x2)	yes
-4.799	22.384	-0.442	23.03	+ (y > x2)	- (y < x2)	no
-3.058	11.256	-0.344	9.351	+ (y > x2)	+ (y > x2)	yes
1.044	-1.733	-0.222	1.09	- (y < x2)	- (y < x2)	yes
4.905	26.056	-0.448	24.059	+ (y > x2)	+ (y > x2)	yes
-7.056	53.366	-0.553	49.787	+ (y > x2)	+ (y > x2)	yes
-8.332	75.616	-0.613	69.422	+ (y > x2)	+ (y > x2)	yes
-5.158	25.873	-0.462	26.605	+ (y > x2)	- (y < x2)	no
4.405	20.109	-0.42	19.404	+ (y > x2)	+ (y > x2)	yes
-6.843	55.262	-0.542	46.827	+ (y > x2)	+ (y > x2)	yes
7.716	66.582	-0.584	59.537	+ (y > x2)	+ (y > x2)	yes
8.358	68.3	-0.614	69.856	+ (y > x2)	- (y < x2)	no
-7.582	63.323	-0.577	57.487	+ (y > x2)	+ (y > x2)	yes
-9.829	91.374	-0.686	96.609	+ (y > x2)	- (y < x2)	no
1.871	4.03	-0.275	3.501	+ (y > x2)	+ (y > x2)	yes
-9.635	89.514	-0.677	92.833	+ (y > x2)	- (y < x2)	no
6.361	36.706	-0.52	40.462	+ (y > x2)	- (y < x2)	no
8.989	84.391	-0.645	80.802	+ (y > x2)	+ (y > x2)	yes
-0.759	-5.137	-0.205	0.576	- (y < x2)	- (y < x2)	yes

```
-7.325    | 53.533    | -0.565    | 53.656    | + (y > x2) | - (y < x2)    | no
-7.864    | 71.207    | -0.591    | 61.842    | + (y > x2) | + (y > x2)    | yes
5.834     | 32.034    | -0.495    | 34.036    | + (y > x2) | - (y < x2)    | no

# tested  : 50
# correct : 27

# of y > x2 label: 24
# of y < x2 label: 26

# of y > x2 NN: 47
# of y < x2 NN: 3

% correct guess : 54.0%
% x2 NN and label diff (median) : 101.588%
% x2 NN and label diff (average): 103.682%

--- Training now... ---
Epoch #5  loss: 2.185
Epoch #10 loss: 1.629
Epoch #15 loss: 1.382
Epoch #20 loss: 0.795
Epoch #25 loss: 0.179
Epoch #30 loss: 0.668

--- Testing data after training... ---
x         | y         | x2 NN     | x2 label  | y vs x2 NN | y vs x2 label | correct?
----------+-----------+-----------+-----------+------------+---------------+---------
-9.558    | 81.86     | 80.124    | 91.355    | + (y > x2) | - (y < x2)    | no
6.266     | 48.413    | 33.762    | 39.263    | + (y > x2) | + (y > x2)    | yes
-4.488    | 29.343    | 18.167    | 20.142    | + (y > x2) | + (y > x2)    | yes
6.54      | 41.154    | 36.8      | 42.772    | + (y > x2) | - (y < x2)    | no
-3.437    | 10.967    | 10.985    | 11.813    | - (y < x2) | - (y < x2)    | yes
3.336     | 12.753    | 10.295    | 11.129    | + (y > x2) | + (y > x2)    | yes
-2.45     | 1.722     | 6.146     | 6.003     | - (y < x2) | - (y < x2)    | yes
4.02      | 25.046    | 14.966    | 16.16     | + (y > x2) | + (y > x2)    | yes
1.858     | 8.107     | 3.43      | 3.452     | + (y > x2) | + (y > x2)    | yes
7.311     | 56.258    | 45.348    | 53.451    | + (y > x2) | + (y > x2)    | yes
-7.155    | 54.266    | 43.618    | 51.194    | + (y > x2) | + (y > x2)    | yes
-3.703    | 7.179     | 12.801    | 13.712    | - (y < x2) | - (y < x2)    | yes
-3.582    | 10.784    | 11.975    | 12.831    | - (y < x2) | - (y < x2)    | yes
-3.253    | 12.744    | 9.728     | 10.582    | + (y > x2) | + (y > x2)    | yes
4.501     | 11.135    | 18.257    | 20.259    | - (y < x2) | - (y < x2)    | yes
4.283     | 14.257    | 16.762    | 18.344    | - (y < x2) | - (y < x2)    | yes
-3.045    | 16.984    | 8.394     | 9.272     | + (y > x2) | + (y > x2)    | yes
-9.341    | 82.497    | 76.693    | 87.254    | + (y > x2) | - (y < x2)    | no
0.98      | -2.391    | 1.033     | 0.96      | - (y < x2) | - (y < x2)    | yes
7.506     | 54.727    | 47.678    | 56.34     | + (y > x2) | - (y < x2)    | no
-5.466    | 22.104    | 24.989    | 29.877    | - (y < x2) | - (y < x2)    | yes
8.886     | 73.611    | 69.498    | 78.961    | + (y > x2) | - (y < x2)    | no
2.505     | 14.168    | 6.351     | 6.275     | + (y > x2) | + (y > x2)    | yes
5.511     | 34.928    | 25.476    | 30.371    | + (y > x2) | + (y > x2)    | yes
-3.114    | 4.802     | 8.779     | 9.697     | - (y < x2) | - (y < x2)    | yes
8.197     | 67.046    | 58.604    | 67.191    | + (y > x2) | - (y < x2)    | no
-8.396    | 65.367    | 61.751    | 70.493    | + (y > x2) | - (y < x2)    | no
-9.848    | 105.347   | 84.709    | 96.983    | + (y > x2) | + (y > x2)    | yes
-1.618    | 3.579     | 2.736     | 2.618     | + (y > x2) | + (y > x2)    | yes
-4.799    | 22.384    | 20.301    | 23.03     | + (y > x2) | - (y < x2)    | no
-3.058    | 11.256    | 8.443     | 9.351     | + (y > x2) | + (y > x2)    | yes
1.044     | -1.733    | 1.204     | 1.09      | - (y < x2) | - (y < x2)    | yes
4.905     | 26.056    | 21.028    | 24.059    | + (y > x2) | + (y > x2)    | yes
-7.056    | 53.366    | 42.52     | 49.787    | + (y > x2) | + (y > x2)    | yes
-8.332    | 75.616    | 60.739    | 69.422    | + (y > x2) | + (y > x2)    | yes
-5.158    | 25.873    | 22.764    | 26.605    | + (y > x2) | - (y < x2)    | no
4.405     | 20.109    | 17.598    | 19.404    | + (y > x2) | + (y > x2)    | yes
-6.843    | 55.262    | 40.159    | 46.827    | + (y > x2) | + (y > x2)    | yes
7.716     | 66.582    | 50.999    | 59.537    | + (y > x2) | + (y > x2)    | yes
8.358     | 68.3      | 61.15     | 69.856    | + (y > x2) | - (y < x2)    | no
-7.582    | 63.323    | 48.88     | 57.487    | + (y > x2) | + (y > x2)    | yes
-9.829    | 91.374    | 84.409    | 96.609    | + (y > x2) | - (y < x2)    | no
1.871     | 4.03      | 3.479     | 3.501     | + (y > x2) | + (y > x2)    | yes
-9.635    | 89.514    | 81.341    | 92.833    | + (y > x2) | - (y < x2)    | no
```

```
6.361     | 36.706    | 34.815    | 40.462    | + (y > x2) | - (y < x2)    | no
8.989     | 84.391    | 71.127    | 80.802    | + (y > x2) | + (y > x2)    | yes
-0.759    | -5.137    | 0.512     | 0.576     | - (y < x2) | - (y < x2)    | yes
-7.325    | 53.533    | 45.503    | 53.656    | + (y > x2) | - (y < x2)    | no
-7.864    | 71.207    | 53.339    | 61.842    | + (y > x2) | + (y > x2)    | yes
5.834     | 32.034    | 28.972    | 34.036    | + (y > x2) | - (y < x2)    | no

# tested  : 50
# correct : 35

# of y > x2 label: 24
# of y < x2 label: 26

# of y > x2 NN: 39
# of y < x2 NN: 11

% correct guess : 70.0%
% x2 NN and label diff (median) : 12.199%
% x2 NN and label diff (average): 10.896%

--- Plotting test results before and after... ---
```