

Hyperparameters:

1. Number of hidden layers
2. Number of units in each hidden layer
3. Learning rate
4. Mini-batch size
5. Epochs

Experiments:

# Hidden Layers	# units in each hidden layer	Learning rate	Mini-batch size	Epochs	Confusion Matrix
2	30	3.0	10	30	2_hidden_layers: 0.9518 <pre> [[0 0 1 2 3 4 5 6 7 8 9] [0 957 0 5 0 0 6 5 1 4 8] [1 0 1120 1 3 0 4 3 10 3 8] [2 3 2 987 14 5 7 2 15 11 2] [3 3 4 12 965 2 25 4 10 15 18] [4 0 0 6 0 936 1 6 4 3 29] [5 2 1 2 8 0 819 7 2 7 8] [6 11 3 5 1 6 11 928 0 3 0] [7 2 2 4 5 4 1 0 972 3 11] [8 1 3 9 11 6 15 3 1 923 14] [9 1 0 1 3 23 3 0 13 2 911]] </pre>
4	30	3.0	10	30	4_hidden_layers: 0.9468 <pre> [[0 0 1 2 3 4 5 6 7 8 9] [0 957 0 5 0 2 5 9 1 4 4] [1 0 1117 1 2 1 0 2 5 1 7] [2 4 5 990 17 8 4 9 14 8 1] [3 0 2 8 921 1 19 1 8 10 3] [4 0 0 6 0 933 2 13 4 7 31] [5 7 2 2 24 1 835 12 0 15 10] [6 6 1 1 0 6 6 902 0 6 1] [7 3 4 7 12 4 4 2 983 7 23] [8 3 4 12 29 1 14 7 5 913 12] [9 0 0 0 5 25 3 1 8 3 917]] </pre>
6	30	3.0	10	30	6_hidden_layers: 0.9371 <pre> [[0 0 1 2 3 4 5 6 7 8 9] [0 954 0 9 1 1 6 6 2 3 4] [1 0 1112 7 0 0 1 2 12 3 2] [2 2 2 922 17 4 0 4 17 3 1] [3 3 3 31 948 1 21 0 7 15 12] [4 0 1 8 0 933 1 4 4 9 48] [5 7 0 2 17 2 828 18 1 10 5] [6 5 2 5 0 6 9 916 1 7 0] [7 2 0 8 6 2 2 2 940 6 11] [8 3 13 35 15 2 13 6 1 909 17] [9 4 2 5 6 31 11 0 43 9 909]] </pre>
1	15	3.0	10	30	15_units_hl: 0.9307 <pre> [[0 0 1 2 3 4 5 6 7 8 9] [0 952 0 14 8 1 15 14 5 16 12] [1 0 1110 3 2 1 0 1 15 3 8] [2 2 2 960 14 2 6 7 21 9 1] [3 0 2 15 924 1 23 2 8 16 11] [4 1 1 11 0 925 1 10 8 11 33] [5 1 2 2 39 0 797 16 3 22 7] [6 12 4 7 0 20 12 903 1 9 1] [7 4 3 5 7 1 0 0 943 8 8] [8 6 11 15 14 8 27 5 4 876 11] [9 2 0 0 2 23 11 0 20 4 917]] </pre>

1	45	3.0	10	30	15_units_hl: 0.9567 [[0 0 1 2 3 4 5 6 7 8 9] [0 963 0 8 2 1 6 11 1 7 4] [1 0 1117 1 2 0 1 3 4 2 4] [2 2 5 981 9 4 1 3 13 7 1] [3 1 3 11 964 1 31 2 11 12 14] [4 1 0 4 0 938 2 6 0 7 14] [5 5 1 3 8 2 821 5 2 5 4] [6 4 3 7 2 8 13 925 0 5 1] [7 2 4 6 11 6 2 1 990 11 10] [8 2 1 8 9 2 10 2 0 918 7] [9 0 1 3 3 20 5 0 7 0 950]]
1	60	3.0	10	30	60_units_hl: 0.9589 [[0 0 1 2 3 4 5 6 7 8 9] [0 965 0 7 1 2 5 11 3 7 8] [1 0 1119 1 2 0 0 2 5 0 5] [2 1 1 974 12 1 0 2 12 4 1] [3 0 3 15 958 0 9 0 3 11 12] [4 0 0 6 1 946 2 3 3 8 15] [5 4 1 4 15 0 853 11 0 10 5] [6 6 5 4 1 4 12 926 1 1 1] [7 1 1 9 10 2 3 0 981 9 8] [8 2 4 9 7 0 3 2 4 916 3] [9 1 1 3 3 27 5 1 16 8 951]]
1	30	0.5	10	30	0.5_eta: 0.94 [[0 0 1 2 3 4 5 6 7 8 9] [0 957 0 6 5 1 7 14 2 10 8] [1 0 1113 2 0 0 1 3 9 6 6] [2 1 3 966 18 3 6 5 19 9 2] [3 2 2 11 925 1 19 0 9 17 13] [4 5 0 9 2 934 5 8 7 9 25] [5 4 3 6 22 0 819 14 2 20 7] [6 8 3 10 3 8 13 911 1 9 1] [7 1 3 10 14 2 1 1 965 8 12] [8 2 8 10 18 4 17 2 0 884 9] [9 0 0 2 3 29 4 0 14 2 926]]
1	30	1	10	30	1_eta: 0.1287 [[0 0 1 2 3 4 5 6 7 8 9] [0 292 25 105 43 146 113 146 554 86 125] [1 0 1 0 1 2 2 0 1 0 1] [2 0 0 0 2 0 0 2 0 1 1] [3 253 547 703 506 610 316 586 100 572 428] [4 3 0 3 13 0 3 1 0 2 0] [5 2 0 1 0 0 1 0 0 1 1] [6 0 0 0 0 0 0 0 0 0 0] [7 30 33 13 34 5 42 7 8 5 0] [8 349 368 167 305 67 329 149 182 108 82] [9 51 161 40 106 152 86 67 183 199 371]]
1	30	5	10	30	5_eta: 0.1157 [[0 0 1 2 3 4 5 6 7 8 9] [0 2 20 33 20 33 5 13 12 12 12] [1 1 0 0 8 2 5 1 0 0 0] [2 0 0 0 0 0 0 0 0 0 0] [3 212 58 173 101 32 53 95 75 79 16] [4 1 0 0 0 1 0 0 0 0 0] [5 257 5 45 99 125 204 39 31 182 49] [6 44 4 34 18 72 22 23 15 39 81] [7 3 16 2 25 103 19 3 42 20 71] [8 0 0 29 2 13 2 9 5 4 0] [9 460 1032 716 737 601 582 775 848 638 780]]

1	30	5.0	10	30	5_0_eta: 0.9465 [[0 0 1 2 3 4 5 6 7 8 9] [0 965 0 11 3 1 6 12 2 12 8] [1 0 1111 2 0 2 0 1 5 2 5] [2 1 6 971 18 6 2 5 15 5 0] [3 2 1 6 911 0 12 0 4 7 8] [4 3 1 3 1 926 4 5 5 5 23] [5 1 2 4 45 0 848 9 0 13 12] [6 3 4 6 3 11 7 922 0 11 1] [7 1 3 9 11 5 1 0 970 6 11] [8 4 7 19 15 4 9 4 5 910 10] [9 0 0 1 3 27 3 0 22 3 931]]
1	30	3.0	5	30	5_mini_batch: 0.9491 [[0 0 1 2 3 4 5 6 7 8 9] [0 960 0 12 4 3 3 11 2 8 5] [1 0 1113 1 2 2 1 1 5 0 5] [2 2 6 971 14 4 4 5 28 2 1] [3 0 0 5 937 0 12 1 9 6 10] [4 3 0 6 0 932 2 6 3 7 17] [5 2 0 4 15 1 835 8 1 6 10] [6 6 3 6 2 15 13 919 1 9 3] [7 1 1 8 8 2 2 0 963 6 11] [8 5 12 18 24 6 16 7 4 927 13] [9 1 0 1 4 17 4 0 12 3 934]]
1	30	3.0	25	30	25_mini_batch: 0.9501 [[0 0 1 2 3 4 5 6 7 8 9] [0 966 0 8 2 1 5 13 2 6 7] [1 1 1115 2 0 3 2 3 6 3 3] [2 2 1 972 16 4 4 6 13 4 2] [3 0 4 3 952 0 22 1 6 12 7] [4 0 1 12 1 926 2 7 4 8 22] [5 2 2 1 14 0 825 4 0 6 5] [6 4 4 7 2 13 14 919 0 14 0] [7 2 3 11 8 2 2 1 982 6 17] [8 2 5 14 7 4 11 4 1 910 12] [9 1 0 2 8 29 5 0 14 5 934]]
1	30	3.0	50	30	50_mini_batch: 0.9403 [[0 0 1 2 3 4 5 6 7 8 9] [0 952 0 9 1 2 10 10 1 8 9] [1 0 1113 2 1 0 3 1 7 1 7] [2 2 5 959 18 3 3 2 19 4 1] [3 2 1 14 937 1 18 0 10 18 9] [4 1 1 12 0 928 2 8 9 8 30] [5 7 2 1 22 0 815 10 0 12 11] [6 10 4 9 1 14 15 920 1 5 1] [7 2 1 8 11 0 2 0 953 5 9] [8 2 8 16 17 4 16 7 5 907 13] [9 2 0 2 2 30 8 0 23 6 919]]
1	30	3.0	10	1	1_epoch: 0.9095 [[0 0 1 2 3 4 5 6 7 8 9] [0 947 0 14 4 1 16 10 2 9 9] [1 1 1108 4 5 6 5 1 10 8 4] [2 3 6 920 20 8 10 6 24 15 3] [3 2 3 17 901 0 38 0 6 12 12] [4 0 0 6 1 872 5 8 5 7 26] [5 5 1 6 22 4 756 10 2 20 9] [6 17 4 21 3 22 22 914 7 19 4] [7 1 3 17 16 3 4 3 914 14 15] [8 4 10 17 25 9 29 6 3 849 13] [9 0 0 10 13 57 7 0 55 21 914]]
1	30	3.0	10	15	15_epoch: 0.8583 [[0 0 1 2 3 4 5 6 7 8 9] [0 962 0 13 21 2 11 13 4 8 8] [1 0 1111 3 113 1 2 3 6 0 4] [2 1 6 972 277 5 3 2 18 7 5] [3 0 0 0 10 0 0 0 0 0 0] [4 0 0 6 64 936 2 2 2 9 19] [5 2 0 4 312 0 843 10 2 19 15] [6 8 2 11 3 8 10 924 2 6 1] [7 2 4 12 41 2 6 0 979 14 13] [8 4 12 11 123 4 10 4 3 907 5] [9 1 0 0 46 24 5 0 12 4 939]]

1	30	3.0	10	45	45_epoch: 0.9492
					[[0 0 1 2 3 4 5 6 7 8 9]
					[[0 957 0 9 3 1 8 7 1 8 7]
					[[1 0 1116 3 2 0 0 2 10 3 2]
					[[2 2 2 972 14 3 2 2 16 3 2]
					[[3 1 2 14 938 0 13 1 4 13 7]
					[[4 1 1 4 2 939 4 4 4 13 23]
					[[5 8 1 1 21 0 834 5 0 14 5]
					[[6 6 4 8 3 9 10 933 4 12 0]
					[[7 2 1 9 7 1 4 0 967 9 8]
					[[8 2 7 9 12 2 11 4 2 886 5]
					[[9 1 1 3 8 27 6 0 20 13 950]]