LR: 0.0001	Accuracy	Cross Entropy Loss
Training		
Testing		

LR: 0.001	Accuracy	Cross Entropy Loss
Training		
Testing		

LR: 0.1	Accuracy	Cross Entropy Loss
Training		
Testing		

LR: 1	Accuracy	Cross Entropy Loss
Training		
Testing		

The selection of learning rates significantly affects the training dynamics and convergence of the neural network. Starting with a learning rate of 1, the training and testing accuracies experienced erratic oscillations. The high rate led to drastic weight updates causing overshooting and instability, hindering convergence. Similarly, a learning rate of 0.1 also displayed erratic fluctuations in accuracy across epochs. While not as extreme as the higher rate, this moderately high rate struggled to converge, resulting in inconsistent accuracy patterns. However, when the learning rate dropped to 0.001, a very slight improvement in stability was observed but far from desirable results within 2000 epochs. **Finally, employing a lower learning rate of 0.0001 showcased the most favourable results. This rate facilitated a smooth and consistent increase in both training and testing accuracies across the epochs reaching 0.93 for training accuracy and 0.87 for testing accuracy. The gradual yet persistent updates enabled the model to refine its parameters more precisely, leading to steady convergence and improved generalisation.** It seems the impact of learning rates on the neural network's convergence and stability is evident in this scenario. Higher rates caused instability and oscillations, hindering convergence, while lower rates, particularly 0.0001, allowed for more stable and gradual convergence, resulting in improved accuracy over time.

Training neural network with learning rate: 1, number of epochs: 2000
Epoch 250, Training Cross Entropy Loss: 106.71794960528119, Training Accuracy: 0.2758278650999542
Epoch 250, Testing Cross Entropy Loss: 113.35803534739918, Testing Accuracy: 0.23076923076923078
Epoch 500, Training Cross Entropy Loss: 106.71794960528122, Training Accuracy: 0.2758278650999542
Epoch 500, Testing Cross Entropy Loss: 113.35803534739918, Testing Accuracy: 0.23076923076923078
Epoch 750, Training Cross Entropy Loss: 106.71794960528119, Training Accuracy: 0.2758278650999542
Epoch 750, Testing Cross Entropy Loss: 104.76621600162409, Testing Accuracy: 0.2890720390720391
Epoch 1000, Training Cross Entropy Loss: 111.71033919802642, Training Accuracy: 0.24195025179307186
Epoch 1000, Testing Cross Entropy Loss: 106.52056654866716, Testing Accuracy: 0.2771672771672772
Epoch 1250, Training Cross Entropy Loss: 105.41363160357298, Training Accuracy: 0.28467877308103157
Epoch 1250, Testing Cross Entropy Loss: 106.52056654866718, Testing Accuracy: 0.2771672771672772
Epoch 1500, Training Cross Entropy Loss: 105.413631603573, Training Accuracy: 0.28467877308103157
Epoch 1500, Testing Cross Entropy Loss: 113.35803534739918, Testing Accuracy: 0.23076923076923078
Epoch 1750, Training Cross Entropy Loss: 105.41363160357301, Training Accuracy: 0.28467877308103157
Epoch 1750, Testing Cross Entropy Loss: 106.52056654866718, Testing Accuracy: 0.2771672771672772
Epoch 2000, Training Cross Entropy Loss: 105.41363160357298, Training Accuracy: 0.28467877308103157
Epoch 2000, Testing Cross Entropy Loss: 113.35803534739918, Testing Accuracy: 0.23076923076923078

Training neural network with learning rate: 0.1, number of epochs: 2000
Epoch 250, Training Cross Entropy Loss: 111.74407156013955, Training Accuracy: 0.2417213490004578
Epoch 250, Testing Cross Entropy Loss: 106.43059985394703, Testing Accuracy: 0.2777777777777778
Epoch 500, Training Cross Entropy Loss: 118.18695272374994, Training Accuracy: 0.19800091561117045
Epoch 500, Testing Cross Entropy Loss: 106.43059985394703, Testing Accuracy: 0.2777777777777778
Epoch 750, Training Cross Entropy Loss: 111.74407156013956, Training Accuracy: 0.2417213490004578
Epoch 750, Testing Cross Entropy Loss: 106.43059985394703, Testing Accuracy: 0.2777777777777778
Epoch 1000, Training Cross Entropy Loss: 118.18695272374994, Training Accuracy: 0.19800091561117045
Epoch 1000, Testing Cross Entropy Loss: 106.43059985394703, Testing Accuracy: 0.2777777777777778
Epoch 1250, Training Cross Entropy Loss: 111.74407156013955, Training Accuracy: 0.2417213490004578
Epoch 1250, Testing Cross Entropy Loss: 106.43059985394703, Testing Accuracy: 0.2777777777777778
Epoch 1500, Training Cross Entropy Loss: 118.18695272374994, Training Accuracy: 0.19800091561117045
Epoch 1500, Testing Cross Entropy Loss: 104.81119934898418, Testing Accuracy: 0.28876678876678874
Epoch 1750, Training Cross Entropy Loss: 105.44736396568614, Training Accuracy: 0.2844498702884175
Epoch 1750, Testing Cross Entropy Loss: 106.43059985394703, Testing Accuracy: 0.2777777777777778
Epoch 2000, Training Cross Entropy Loss: 118.18695272374994, Training Accuracy: 0.19800091561117045
Epoch 2000, Testing Cross Entropy Loss: 104.81119934898418, Testing Accuracy: 0.28876678876678874

Training neural network with learning rate: 0.001, number of epochs: 2000
Epoch 250, Training Cross Entropy Loss: 105.44736396568614, Training Accuracy: 0.2844498702884175
Epoch 250, Testing Cross Entropy Loss: 106.430599853947, Testing Accuracy: 0.2777777777777778
Epoch 500, Training Cross Entropy Loss: 118.18695272374994, Training Accuracy: 0.19800091561117045
Epoch 500, Testing Cross Entropy Loss: 113.31305200003911, Testing Accuracy: 0.2310744810744811
Epoch 750, Training Cross Entropy Loss: 111.74407156013955, Training Accuracy: 0.2417213490004578
Epoch 750, Testing Cross Entropy Loss: 104.81119934898418, Testing Accuracy: 0.28876678876678874
Epoch 1000, Training Cross Entropy Loss: 118.18695272374994, Training Accuracy: 0.19800091561117045
Epoch 1000, Testing Cross Entropy Loss: 113.31305200003911, Testing Accuracy: 0.2310744810744811
Epoch 1250, Training Cross Entropy Loss: 111.74407156013955, Training Accuracy: 0.2417213490004578
Epoch 1250, Testing Cross Entropy Loss: 104.81119934898418, Testing Accuracy: 0.28876678876678874
Epoch 1500, Training Cross Entropy Loss: 118.18695272374995, Training Accuracy: 0.19800091561117045
Epoch 1500, Testing Cross Entropy Loss: 104.81119934898418, Testing Accuracy: 0.28876678876678874
Epoch 1750, Training Cross Entropy Loss: 111.74407156013955, Training Accuracy: 0.2417213490004578
Epoch 1750, Testing Cross Entropy Loss: 104.81119934898418, Testing Accuracy: 0.28876678876678874
Epoch 2000, Training Cross Entropy Loss: 105.44736396568614, Training Accuracy: 0.2844498702884175
Epoch 2000, Testing Cross Entropy Loss: 117.54148665188654, Testing Accuracy: 0.20238095238095238

Training neural network with learning rate: 0.0001, number of epochs: 2000
Epoch 250, Training Cross Entropy Loss: 87.8165827012165 3, Training Accuracy: 0.4040897298947047
Epoch 250, Testing Cross Entropy Loss: 114.88746915764187, Testing Accuracy: 0.22039072039072038
Epoch 500, Training Cross Entropy Loss: 84.58952005905917, Training Accuracy: 0.4259880097054784 1
Epoch 500, Testing Cross Entropy Loss: 89.60682794127744, Testing Accuracy: 0.3919413914139194
Epoch 750, Training Cross Entropy Loss: 52.66746137932116, Training Accuracy: 0.6426064397985656
Epoch 750, Testing Cross Entropy Loss: 50.11144895912805, Testing Accuracy: 0.6599511599511599
Epoch 1000, Training Cross Entropy Loss: 17.30470176404254, Training Accuracy: 0.8825728673898821
Epoch 1000, Testing Cross Entropy Loss: 24.470940963883002, Testing Accuracy: 0.833943833943834
Epoch 1250, Training Cross Entropy Loss: 20.531764406199922, Training Accuracy: 0.8606745002289028
Epoch 1250, Testing Cross Entropy Loss: 22.40170698531936, Testing Accuracy: 0.847985347985348
Epoch 1500, Training Cross Entropy Loss: 33.10269135369801, Training Accuracy: 0.775370059514726
Epoch 1500, Testing Cross Entropy Loss: 28.429475531569956, Testing Accuracy: 0.8070818070818071
Epoch 1750, Training Cross Entropy Loss: 34.41825347611061, Training Accuracy: 0.7664428506027774
Epoch 1750, Testing Cross Entropy Loss: 30.093859383892877, Testing Accuracy: 0.7957875457875457
Epoch 2000, Training Cross Entropy Loss: 9.681187926472143, Training Accuracy: 0.934304898519762
Epoch 2000, Testing Cross Entropy Loss: 18.35320572291225, Testing Accuracy: 0.8754578754578755