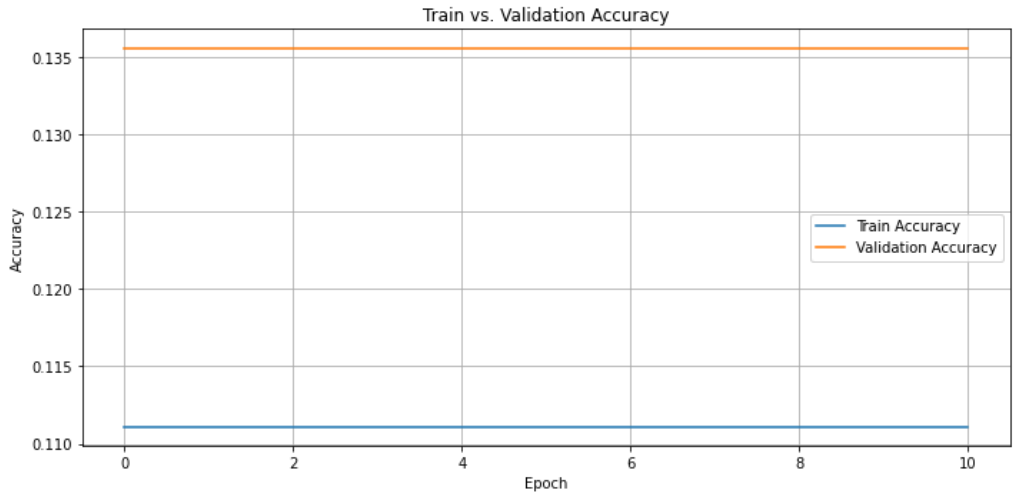
RNN-LSTM as implemented in paper:

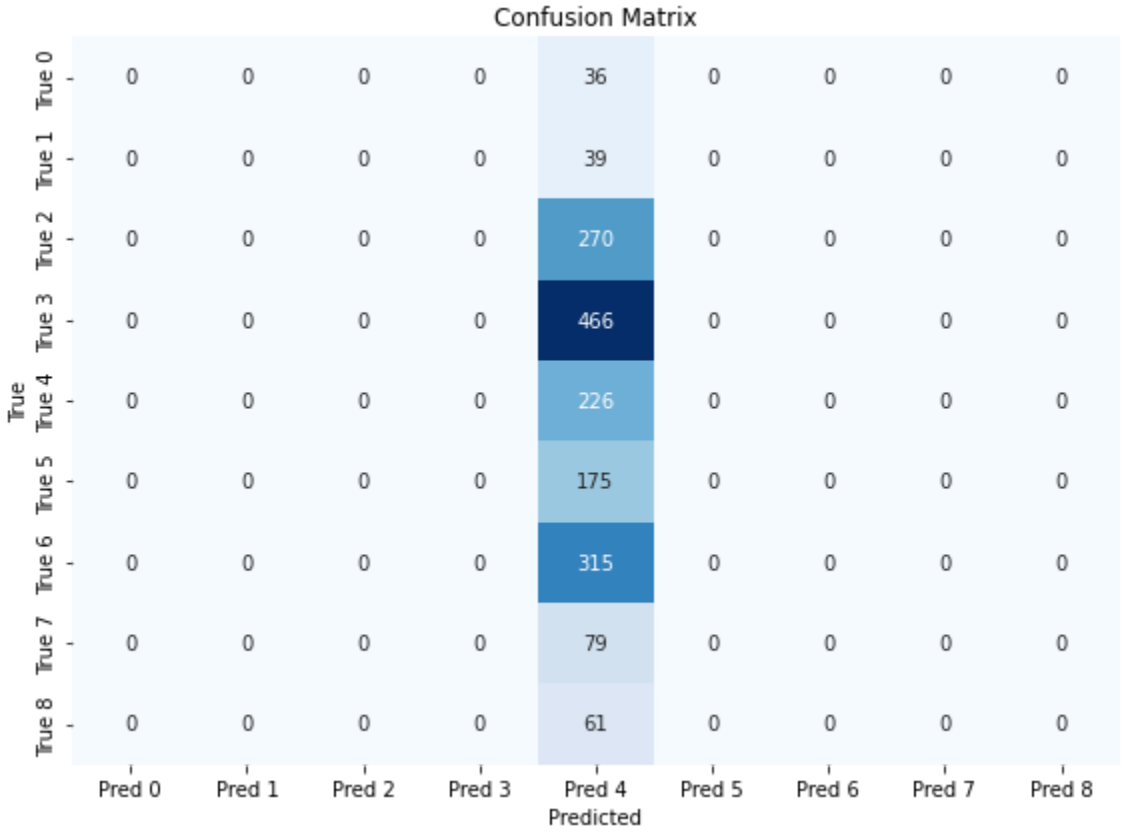
- 250-250-50 hidden layers
- ReLu in hidden layers
- stochastic gradient descent
- adam optimizer
- learning rate .0001
- L2 regularization with 0.1 probability

```
Running configuration 1/1
Batch Size: 64, Learning Rate: 0.0001, Layers: [250, 250, 50], Dropout: 0.5
Using device: cuda
Model architecture: [250, 250, 50], Dropout: 0.5, LR: 0.0001
Epoch 1 | Train Loss: 2.1991 | Train Acc: 0.1111 | Val Acc: 0.1356
Epoch 2 | Train Loss: 2.1986 | Train Acc: 0.1111 | Val Acc: 0.1356
Epoch 3 | Train Loss: 2.1983 | Train Acc: 0.1111 | Val Acc: 0.1356
Epoch 4 | Train Loss: 2.1981 | Train Acc: 0.1111 | Val Acc: 0.1356
Epoch 5 | Train Loss: 2.1979 | Train Acc: 0.1111 | Val Acc: 0.1356
Epoch 6 | Train Loss: 2.1978 | Train Acc: 0.1111 | Val Acc: 0.1356
Epoch 7 | Train Loss: 2.1977 | Train Acc: 0.1111 | Val Acc: 0.1356
Epoch 8 | Train Loss: 2.1976 | Train Acc: 0.1111 | Val Acc: 0.1356
Epoch 9 | Train Loss: 2.1975 | Train Acc: 0.1111 | Val Acc: 0.1356
Epoch 10 | Train Loss: 2.1975 | Train Acc: 0.1111 | Val Acc: 0.1356
Epoch 11 | Train Loss: 2.1974 | Train Acc: 0.1111 | Val Acc: 0.1356
Early stopping triggered after 11 epochs. Best Val Acc: 0.1356
```



Classification Report:

	precision	recall	f1-score	support
0	0.00	0.00	0.00	36
1	0.00	0.00	0.00	39
2	0.00	0.00	0.00	270
3	0.00	0.00	0.00	466
4	0.14	1.00	0.24	226
5	0.00	0.00	0.00	175
6	0.00	0.00	0.00	315
7	0.00	0.00	0.00	79
8	0.00	0.00	0.00	61
accuracy			0.14	1667
macro avg	0.02	0.11	0.03	1667
weighted avg	0.02	0.14	0.03	1667

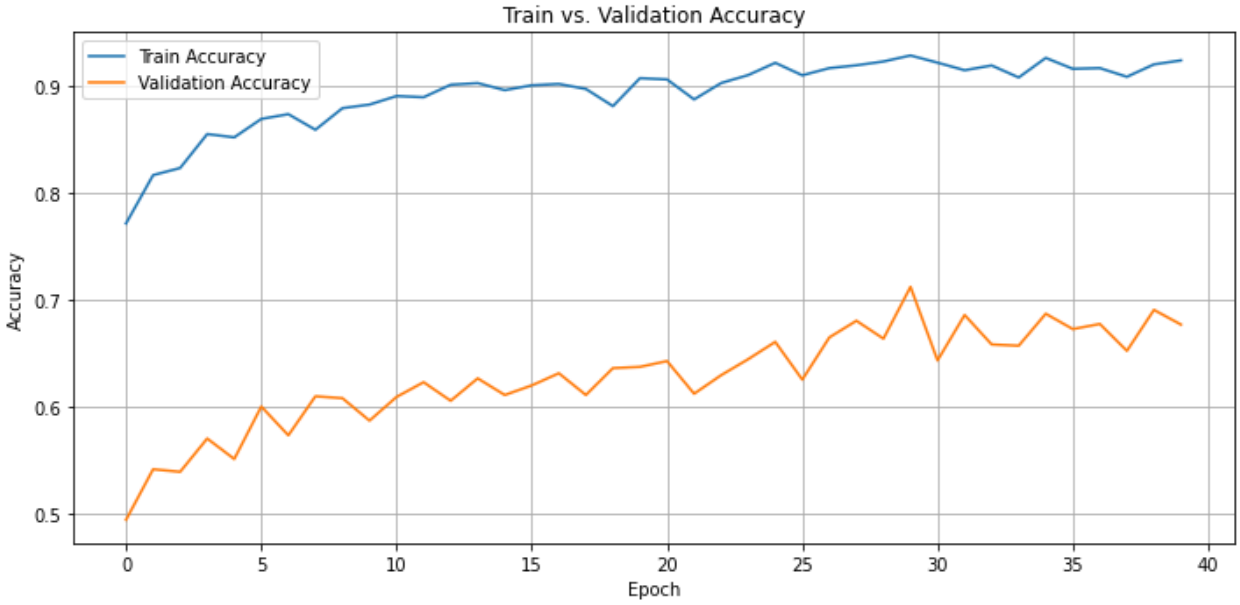


1D-CNN as implemented in paper:

- 2 convolutional layers with filter sizes 64 and kernel sizes 3
- adam optimizer
- 0.5 dropout probability
- pooling layer of size 2
- flattened using 1 hidden layer (size 500, ReLu)

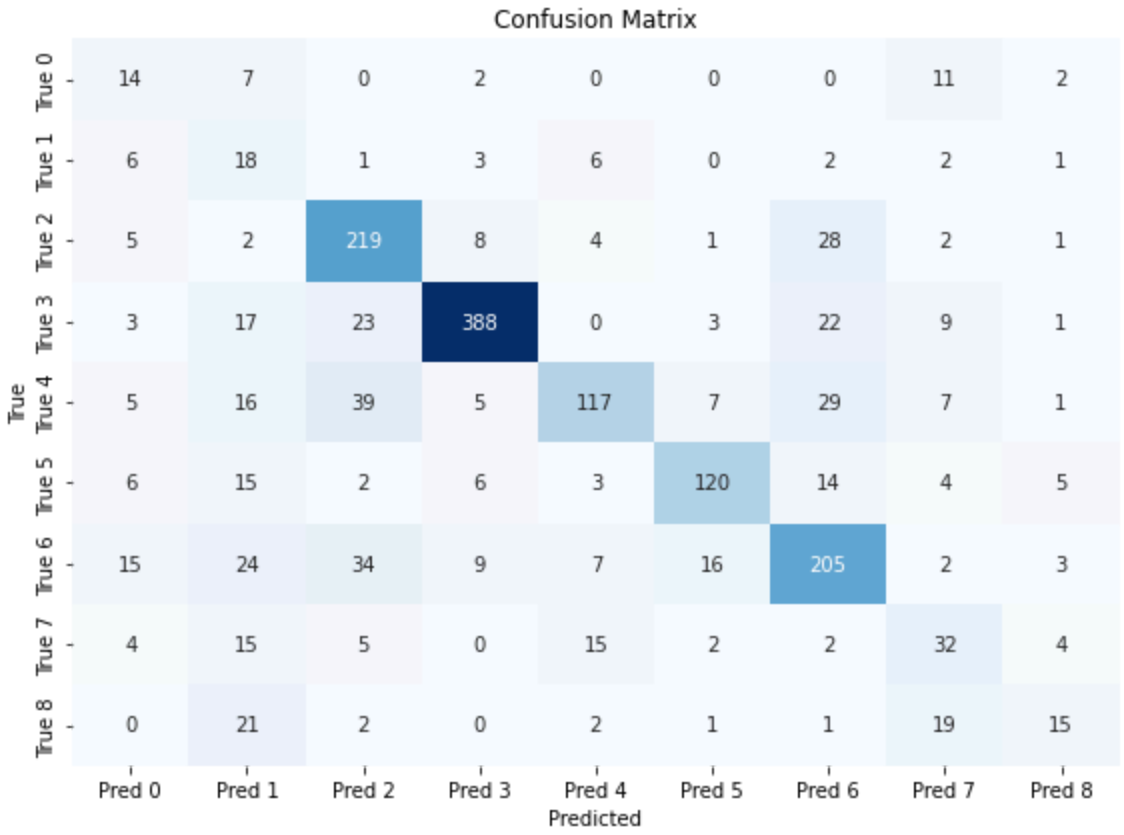
```
Running configuration 1/1
Batch Size: 64, Learning Rate: 0.0001, Layers: [500], Dropout: 0.5
Using device: cuda
Model architecture: [500], Dropout: 0.5, LR: 0.0001
Epoch 1 | Train Loss: 1.2324 | Train Acc: 0.7715 | Val Acc: 0.4937
Epoch 2 | Train Loss: 0.8091 | Train Acc: 0.8168 | Val Acc: 0.5411
Epoch 3 | Train Loss: 0.7241 | Train Acc: 0.8234 | Val Acc: 0.5387
Epoch 4 | Train Loss: 0.6670 | Train Acc: 0.8552 | Val Acc: 0.5699
Epoch 5 | Train Loss: 0.6387 | Train Acc: 0.8522 | Val Acc: 0.5507
Epoch 6 | Train Loss: 0.6118 | Train Acc: 0.8694 | Val Acc: 0.5999
Epoch 7 | Train Loss: 0.5867 | Train Acc: 0.8739 | Val Acc: 0.5729
Epoch 8 | Train Loss: 0.5689 | Train Acc: 0.8593 | Val Acc: 0.6095
Epoch 9 | Train Loss: 0.5559 | Train Acc: 0.8795 | Val Acc: 0.6077
Epoch 10 | Train Loss: 0.5488 | Train Acc: 0.8829 | Val Acc: 0.5867
Epoch 11 | Train Loss: 0.5393 | Train Acc: 0.8909 | Val Acc: 0.6089
Epoch 12 | Train Loss: 0.5277 | Train Acc: 0.8898 | Val Acc: 0.6227
Epoch 13 | Train Loss: 0.5159 | Train Acc: 0.9015 | Val Acc: 0.6053
Epoch 14 | Train Loss: 0.5102 | Train Acc: 0.9030 | Val Acc: 0.6263
Epoch 15 | Train Loss: 0.4983 | Train Acc: 0.8964 | Val Acc: 0.6107
Epoch 16 | Train Loss: 0.5030 | Train Acc: 0.9010 | Val Acc: 0.6197
Epoch 17 | Train Loss: 0.4988 | Train Acc: 0.9022 | Val Acc: 0.6311
Epoch 18 | Train Loss: 0.4947 | Train Acc: 0.8975 | Val Acc: 0.6107
Epoch 19 | Train Loss: 0.4865 | Train Acc: 0.8814 | Val Acc: 0.6359
Epoch 20 | Train Loss: 0.4823 | Train Acc: 0.9076 | Val Acc: 0.6371
Epoch 21 | Train Loss: 0.4812 | Train Acc: 0.9064 | Val Acc: 0.6425
Epoch 22 | Train Loss: 0.4754 | Train Acc: 0.8877 | Val Acc: 0.6119
Epoch 23 | Train Loss: 0.4712 | Train Acc: 0.9031 | Val Acc: 0.6293
Epoch 24 | Train Loss: 0.4640 | Train Acc: 0.9105 | Val Acc: 0.6443
Epoch 25 | Train Loss: 0.4645 | Train Acc: 0.9220 | Val Acc: 0.6605
Epoch 26 | Train Loss: 0.4600 | Train Acc: 0.9103 | Val Acc: 0.6251
Epoch 27 | Train Loss: 0.4655 | Train Acc: 0.9171 | Val Acc: 0.6647
Epoch 28 | Train Loss: 0.4639 | Train Acc: 0.9197 | Val Acc: 0.6803
Epoch 29 | Train Loss: 0.4609 | Train Acc: 0.9233 | Val Acc: 0.6635
Epoch 30 | Train Loss: 0.4591 | Train Acc: 0.9289 | Val Acc: 0.7121
Epoch 31 | Train Loss: 0.4528 | Train Acc: 0.9222 | Val Acc: 0.6431
Epoch 32 | Train Loss: 0.4552 | Train Acc: 0.9151 | Val Acc: 0.6857
```

```
Epoch 33 | Train Loss: 0.4543 | Train Acc: 0.9195 | Val Acc: 0.6581
Epoch 34 | Train Loss: 0.4518 | Train Acc: 0.9083 | Val Acc: 0.6569
Epoch 35 | Train Loss: 0.4479 | Train Acc: 0.9266 | Val Acc: 0.6869
Epoch 36 | Train Loss: 0.4524 | Train Acc: 0.9164 | Val Acc: 0.6725
Epoch 37 | Train Loss: 0.4497 | Train Acc: 0.9171 | Val Acc: 0.6773
Epoch 38 | Train Loss: 0.4543 | Train Acc: 0.9089 | Val Acc: 0.6521
Epoch 39 | Train Loss: 0.4454 | Train Acc: 0.9206 | Val Acc: 0.6905
Epoch 40 | Train Loss: 0.4425 | Train Acc: 0.9243 | Val Acc: 0.6767
Early stopping triggered after 40 epochs. Best Val Acc: 0.7121
```



Classification Report:

	precision	recall	f1-score	support
0	0.24	0.39	0.30	36
1	0.13	0.46	0.21	39
2	0.67	0.81	0.74	270
3	0.92	0.83	0.87	466
4	0.76	0.52	0.62	226
5	0.80	0.69	0.74	175
6	0.68	0.65	0.66	315
7	0.36	0.41	0.38	79
8	0.45	0.25	0.32	61
accuracy			0.68	1667
macro avg	0.56	0.56	0.54	1667
weighted avg	0.72	0.68	0.69	1667


Confusion Matrix
True
True 0
True 1
True 2
True 3
True 4
True 5
True 6
True 7
True 8
14 7 0 2 0 0 0 11 2
6 18 1 3 6 0 2 2 1
5 2 219 8 4 1 28 2 1
3 17 23 388 0 3 22 9 1
5 16 39 5 117 7 29 7 1
6 15 2 6 3 120 14 4 5
15 24 34 9 7 16 205 2 3
4 15 5 0 15 2 2 32 4
0 21 2 0 2 1 1 19 15
Pred 0
Pred 1
Pred 2
Pred 3
Pred 4
Pred 5
Pred 6
Pred 7
Pred 8
Predicted

1D-CNN for F8

- Batch Size: 64
- Learning Rate: 0.0002
- Convolutional Layers:
    - 5 layers with the following (out_channels, kernel_size) pairs: (8, 10) → (32, 10) → (128, 10) → (512, 10) → (128, 10)
    - Each convolution is followed by a ReLU activation
- MaxPooling:
    - MaxPool1d(kernel_size=2) inserted after every 2 convolutional layers
- Fully Connected Layers:
    - One linear layer of size 64 after the convolutional stack
    - Followed by ReLU and dropout
- Dropout Rate: 0.85 applied after each dense layer
- Input Shape: (151, 3) representing 151 time steps and 3 axes (x, y, z)
- Output: Softmax logits over 8 classes (via final linear layer)

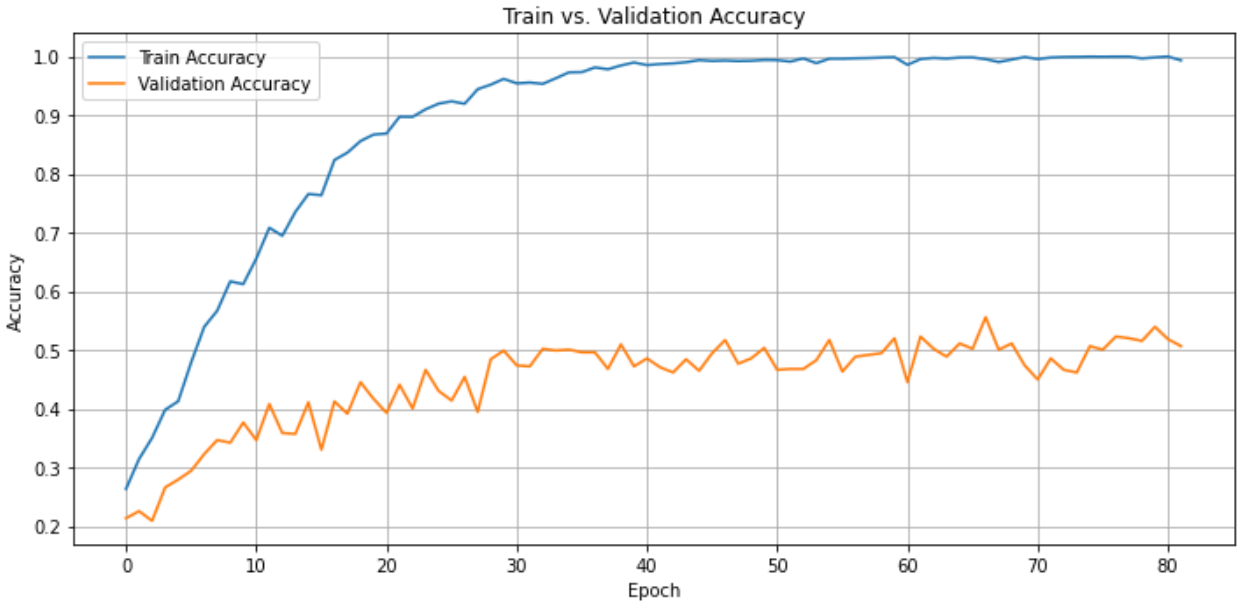
During hyperparameter tuning, I tried many different combinations, including different learning rates, batch sizes, convolutional architecture, linear architecture, and dropout amount. I also tested these same parameters with different models, including LSTMs and Transformers. There was significant overfitting in all the models I tried, though I could not seem to get rid of it.

```
Running configuration 4/8
Model: CNN, Batch Size: 64, LR: 0.0002, Conv: [(8, 10), (32, 10), (128, 10), (512, 10), (128, 10)], Layers: [64], Dropout: 0.85
```

```
Epoch 1 | Train Loss: 2.0475 | Train Acc: 0.2638 | Val Acc: 0.2138
Epoch 2 | Train Loss: 1.9866 | Train Acc: 0.3146 | Val Acc: 0.2257
Epoch 3 | Train Loss: 1.9300 | Train Acc: 0.3506 | Val Acc: 0.2093
Epoch 4 | Train Loss: 1.8766 | Train Acc: 0.3983 | Val Acc: 0.2661
Epoch 5 | Train Loss: 1.8192 | Train Acc: 0.4127 | Val Acc: 0.2795
Epoch 6 | Train Loss: 1.7494 | Train Acc: 0.4791 | Val Acc: 0.2945
Epoch 7 | Train Loss: 1.6744 | Train Acc: 0.5395 | Val Acc: 0.3229
Epoch 8 | Train Loss: 1.6008 | Train Acc: 0.5671 | Val Acc: 0.3468
Epoch 9 | Train Loss: 1.5299 | Train Acc: 0.6170 | Val Acc: 0.3423
Epoch 10 | Train Loss: 1.4868 | Train Acc: 0.6123 | Val Acc: 0.3767
Epoch 11 | Train Loss: 1.4237 | Train Acc: 0.6559 | Val Acc: 0.3468
Epoch 12 | Train Loss: 1.3697 | Train Acc: 0.7083 | Val Acc: 0.4081
Epoch 13 | Train Loss: 1.3101 | Train Acc: 0.6947 | Val Acc: 0.3587
Epoch 14 | Train Loss: 1.2659 | Train Acc: 0.7353 | Val Acc: 0.3572
Epoch 15 | Train Loss: 1.2222 | Train Acc: 0.7658 | Val Acc: 0.4111
Epoch 16 | Train Loss: 1.1579 | Train Acc: 0.7638 | Val Acc: 0.3303
Epoch 17 | Train Loss: 1.1345 | Train Acc: 0.8237 | Val Acc: 0.4126
Epoch 18 | Train Loss: 1.0550 | Train Acc: 0.8364 | Val Acc: 0.3916
```

```
Epoch 19 | Train Loss: 1.0287 | Train Acc: 0.8559 | Val Acc: 0.4454
Epoch 20 | Train Loss: 0.9858 | Train Acc: 0.8670 | Val Acc: 0.4170
Epoch 21 | Train Loss: 0.9554 | Train Acc: 0.8688 | Val Acc: 0.3931
Epoch 22 | Train Loss: 0.8949 | Train Acc: 0.8974 | Val Acc: 0.4410
Epoch 23 | Train Loss: 0.8860 | Train Acc: 0.8972 | Val Acc: 0.4006
Epoch 24 | Train Loss: 0.8413 | Train Acc: 0.9101 | Val Acc: 0.4664
Epoch 25 | Train Loss: 0.8294 | Train Acc: 0.9196 | Val Acc: 0.4305
Epoch 26 | Train Loss: 0.8033 | Train Acc: 0.9236 | Val Acc: 0.4141
Epoch 27 | Train Loss: 0.7800 | Train Acc: 0.9194 | Val Acc: 0.4544
Epoch 28 | Train Loss: 0.7320 | Train Acc: 0.9443 | Val Acc: 0.3946
Epoch 29 | Train Loss: 0.6983 | Train Acc: 0.9520 | Val Acc: 0.4843
Epoch 30 | Train Loss: 0.6767 | Train Acc: 0.9618 | Val Acc: 0.4993
Epoch 31 | Train Loss: 0.6645 | Train Acc: 0.9543 | Val Acc: 0.4738
Epoch 32 | Train Loss: 0.6696 | Train Acc: 0.9556 | Val Acc: 0.4723
Epoch 33 | Train Loss: 0.6346 | Train Acc: 0.9534 | Val Acc: 0.5022
Epoch 34 | Train Loss: 0.6079 | Train Acc: 0.9629 | Val Acc: 0.4993
Epoch 35 | Train Loss: 0.5780 | Train Acc: 0.9729 | Val Acc: 0.5007
Epoch 36 | Train Loss: 0.5764 | Train Acc: 0.9734 | Val Acc: 0.4963
Epoch 37 | Train Loss: 0.5500 | Train Acc: 0.9813 | Val Acc: 0.4963
Epoch 38 | Train Loss: 0.5515 | Train Acc: 0.9782 | Val Acc: 0.4679
Epoch 39 | Train Loss: 0.5429 | Train Acc: 0.9847 | Val Acc: 0.5097
Epoch 40 | Train Loss: 0.5243 | Train Acc: 0.9898 | Val Acc: 0.4723
Epoch 41 | Train Loss: 0.5048 | Train Acc: 0.9853 | Val Acc: 0.4858
Epoch 42 | Train Loss: 0.4951 | Train Acc: 0.9871 | Val Acc: 0.4709
Epoch 43 | Train Loss: 0.5194 | Train Acc: 0.9882 | Val Acc: 0.4619
Epoch 44 | Train Loss: 0.4936 | Train Acc: 0.9902 | Val Acc: 0.4843
Epoch 45 | Train Loss: 0.4871 | Train Acc: 0.9938 | Val Acc: 0.4649
Epoch 46 | Train Loss: 0.4640 | Train Acc: 0.9925 | Val Acc: 0.4948
Epoch 47 | Train Loss: 0.4550 | Train Acc: 0.9931 | Val Acc: 0.5172
Epoch 48 | Train Loss: 0.4283 | Train Acc: 0.9922 | Val Acc: 0.4768
Epoch 49 | Train Loss: 0.4373 | Train Acc: 0.9927 | Val Acc: 0.4858
Epoch 50 | Train Loss: 0.4211 | Train Acc: 0.9940 | Val Acc: 0.5037
Epoch 51 | Train Loss: 0.4082 | Train Acc: 0.9938 | Val Acc: 0.4664
Epoch 52 | Train Loss: 0.4286 | Train Acc: 0.9913 | Val Acc: 0.4679
Epoch 53 | Train Loss: 0.3995 | Train Acc: 0.9967 | Val Acc: 0.4679
Epoch 54 | Train Loss: 0.4109 | Train Acc: 0.9887 | Val Acc: 0.4828
Epoch 55 | Train Loss: 0.4045 | Train Acc: 0.9962 | Val Acc: 0.5172
Epoch 56 | Train Loss: 0.3821 | Train Acc: 0.9962 | Val Acc: 0.4634
Epoch 57 | Train Loss: 0.3588 | Train Acc: 0.9969 | Val Acc: 0.4888
Epoch 58 | Train Loss: 0.3440 | Train Acc: 0.9973 | Val Acc: 0.4918
Epoch 59 | Train Loss: 0.3775 | Train Acc: 0.9982 | Val Acc: 0.4948
Epoch 60 | Train Loss: 0.3557 | Train Acc: 0.9989 | Val Acc: 0.5202
Epoch 61 | Train Loss: 0.3668 | Train Acc: 0.9858 | Val Acc: 0.4454
Epoch 62 | Train Loss: 0.3636 | Train Acc: 0.9956 | Val Acc: 0.5232
Epoch 63 | Train Loss: 0.3452 | Train Acc: 0.9976 | Val Acc: 0.5022
Epoch 64 | Train Loss: 0.3339 | Train Acc: 0.9964 | Val Acc: 0.4888
Epoch 65 | Train Loss: 0.3318 | Train Acc: 0.9982 | Val Acc: 0.5112
Epoch 66 | Train Loss: 0.3275 | Train Acc: 0.9984 | Val Acc: 0.5022
Epoch 67 | Train Loss: 0.3253 | Train Acc: 0.9953 | Val Acc: 0.5561
Epoch 68 | Train Loss: 0.3659 | Train Acc: 0.9907 | Val Acc: 0.5007
Epoch 69 | Train Loss: 0.4471 | Train Acc: 0.9947 | Val Acc: 0.5112
Epoch 70 | Train Loss: 0.3356 | Train Acc: 0.9991 | Val Acc: 0.4738
Epoch 71 | Train Loss: 0.3546 | Train Acc: 0.9956 | Val Acc: 0.4499
Epoch 72 | Train Loss: 0.3536 | Train Acc: 0.9982 | Val Acc: 0.4858
Epoch 73 | Train Loss: 0.3147 | Train Acc: 0.9991 | Val Acc: 0.4664
Epoch 74 | Train Loss: 0.3360 | Train Acc: 0.9993 | Val Acc: 0.4619
Epoch 75 | Train Loss: 0.3201 | Train Acc: 0.9998 | Val Acc: 0.5067
Epoch 76 | Train Loss: 0.3129 | Train Acc: 0.9996 | Val Acc: 0.5007
Epoch 77 | Train Loss: 0.3018 | Train Acc: 0.9998 | Val Acc: 0.5232
Epoch 78 | Train Loss: 0.3156 | Train Acc: 0.9998 | Val Acc: 0.5202
Epoch 79 | Train Loss: 0.3060 | Train Acc: 0.9967 | Val Acc: 0.5157
Epoch 80 | Train Loss: 0.3113 | Train Acc: 0.9984 | Val Acc: 0.5396
Epoch 81 | Train Loss: 0.2907 | Train Acc: 1.0000 | Val Acc: 0.5187
Epoch 82 | Train Loss: 0.3105 | Train Acc: 0.9933 | Val Acc: 0.5067
```

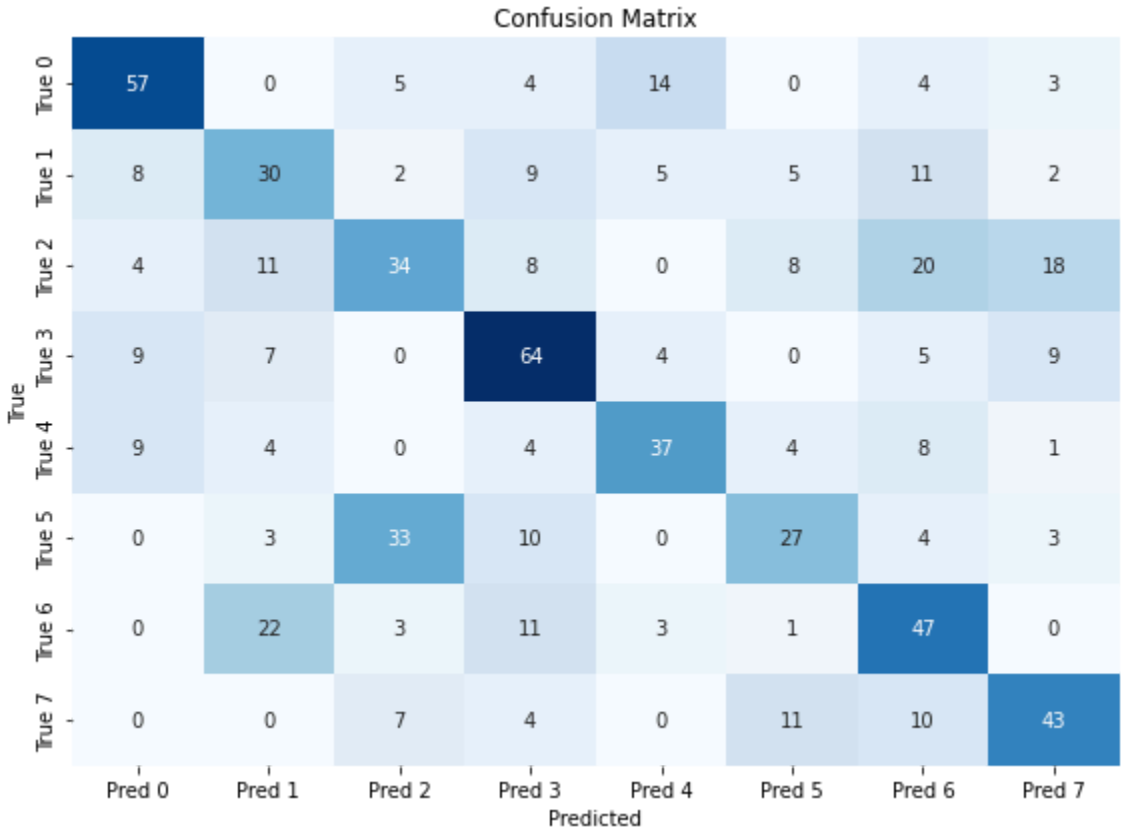
Early stopping triggered after 82 epochs. Best Val Acc: 0.5561



Balanced Accuracy: 0.5073

Classification Report:

	precision	recall	f1-score	support
0	0.66	0.66	0.66	87
1	0.39	0.42	0.40	72
2	0.40	0.33	0.36	103
3	0.56	0.65	0.60	98
4	0.59	0.55	0.57	67
5	0.48	0.34	0.40	80
6	0.43	0.54	0.48	87
7	0.54	0.57	0.56	75
accuracy			0.51	669
macro avg	0.51	0.51	0.50	669
weighted avg	0.51	0.51	0.50	669



Final Validation Accuracy: 0.5067