

1. Late Fusion Networks

This document illustrates the hyperparameters used for the voting models in the CNN and CRNN late fusion networks. By using these parameters in the “CNN_Trainer” and “CRNN_Trainer” scripts, the voting models evaluated in the report can be recreated.

1.1. CNN Models

All models have a learning rate of 0.0001 and a patience of 10. The training/test split remains as stated in the report. Models 1 to 5 (Tables 1-5) have a batch size of 16. Models 6 to 9 (Tables 6-9) have a batch size of 128. Model 10 (Table10) has a batch size of 64.

Table 1 CNN model 1.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	# of Neurons	Rate	Activation
2D Convolutional	8	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
2D Convolutional	32	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
Flatten	-	-	-	-	-	-
Dense	-	-	-	32	-	ReLU
Dropout	-	-	-	-	0.3	-
Dense (Output)	-	-	-	2	-	Softmax

Table 2 CNN model 2.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	# of Neurons	Rate	Activation
2D Convolutional	16	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
2D Convolutional	32	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
Flatten	-	-	-	-	-	-
Dense	-	-	-	32	-	ReLU
Dropout	-	-	-	-	0.3	-
Dense (Output)	-	-	-	2	-	Softmax

Table 3 CNN model 3.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	# of Neurons	Rate	Activation
2D Convolutional	32	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
2D Convolutional	64	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
Flatten	-	-	-	-	-	-
Dense	-	-	-	64	-	ReLU
Dropout	-	-	-	-	0.45	-
Dense (Output)	-	-	-	2	-	Softmax

Table 4 CNN model 4.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	# of Neurons	Rate	Activation
2D Convolutional	8	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
2D Convolutional	16	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
Flatten	-	-	-	-	-	-
Dense	-	-	-	16	-	ReLU
Dropout	-	-	-	-	0.15	-
Dense (Output)	-	-	-	2	-	Softmax

Table 5 CNN model 5.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	# of Neurons	Rate	Activation
2D Convolutional	16	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
2D Convolutional	32	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
Flatten	-	-	-	-	-	-
Dense	-	-	-	32	-	ReLU
Dropout	-	-	-	-	0.4	-
Dense (Output)	-	-	-	2	-	Softmax

Table 6 CNN model 6.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	# of Neurons	Rate	Activation
2D Convolutional	8	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
2D Convolutional	32	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
Flatten	-	-	-	-	-	-
Dense	-	-	-	32	-	ReLU
Dropout	-	-	-	-	0.3	-
Dense (Output)	-	-	-	2	-	Softmax

Table 7 CNN model 7.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	# of Neurons	Rate	Activation
2D Convolutional	16	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
2D Convolutional	32	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
Flatten	-	-	-	-	-	-
Dense	-	-	-	32	-	ReLU
Dropout	-	-	-	-	0.3	-
Dense (Output)	-	-	-	2	-	Softmax

Table 8 CNN model 8.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	# of Neurons	Rate	Activation
2D Convolutional	32	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
2D Convolutional	64	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
Flatten	-	-	-	-	-	-
Dense	-	-	-	64	-	ReLU
Dropout	-	-	-	-	0.45	-
Dense (Output)	-	-	-	2	-	Softmax

Table 9 CNN model 9.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	# of Neurons	Rate	Activation
2D Convolutional	8	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
2D Convolutional	16	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
Flatten	-	-	-	-	-	-
Dense	-	-	-	16	-	ReLU
Dropout	-	-	-	-	0.15	-
Dense (Output)	-	-	-	2	-	Softmax

Table 10 CNN model 10.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	# of Neurons	Rate	Activation
2D Convolutional	8	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
2D Convolutional	32	5x5	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-
Batch Normalization	-	-	-	-	-	-
Flatten	-	-	-	-	-	-
Dense	-	-	-	32	-	ReLU
Dropout	-	-	-	-	0.3	-
Dense (Output)	-	-	-	2	-	Softmax

1.2. CRNN Models

All models have a learning rate of 0.0001 and a patience of 10. The training/test split remains as stated in the report. Models 1 to 5 (Tables 11-15) have a batch size of 16. Models 6 to 9 (Tables 16-19) have a batch size of 128. Model 10 (Table 20) has a batch size of 64.

Table 11 CRNN model 1.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	Memory Units	# of Neurons	Rate	Activation
2D Convolutional	8	5x5	-	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-	-
Batch Normalization	-	-	-	-	-	-	-
Reshape for LSTM	-	-	-	-	-	-	-
LSTM	-	-	-	32	-	-	-
Flatten	-	-	-	-	-	-	-
Dense	-	-	-	-	32	-	ReLU
Dropout	-	-	-	-	-	0.3	-
Dense (Output)	-	-	-	-	2	-	Softmax

Table 12 CRNN model 2.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	Memory Units	# of Neurons	Rate	Activation
2D Convolutional	16	5x5	-	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-	-
Batch Normalization	-	-	-	-	-	-	-
Reshape for LSTM	-	-	-	-	-	-	-
LSTM	-	-	-	32	-	-	-
Flatten	-	-	-	-	-	-	-
Dense	-	-	-	-	32	-	ReLU
Dropout	-	-	-	-	-	0.3	-
Dense (Output)	-	-	-	-	2	-	Softmax

Table 13 CRNN model 3.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	Memory Units	# of Neurons	Rate	Activation
2D Convolutional	32	5x5	-	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-	-
Batch Normalization	-	-	-	-	-	-	-
Reshape for LSTM	-	-	-	-	-	-	-
LSTM	-	-	-	64	-	-	-
Flatten	-	-	-	-	-	-	-
Dense	-	-	-	-	64	-	ReLU
Dropout	-	-	-	-	-	0.45	-
Dense (Output)	-	-	-	-	2	-	Softmax

Table 14 CRNN model 4.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	Memory Units	# of Neurons	Rate	Activation
2D Convolutional	8	5x5	-	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-	-
Batch Normalization	-	-	-	-	-	-	-
Reshape for LSTM	-	-	-	-	-	-	-
LSTM	-	-	-	16	-	-	-
Flatten	-	-	-	-	-	-	-
Dense	-	-	-	-	16	-	ReLU
Dropout	-	-	-	-	-	0.15	-
Dense (Output)	-	-	-	-	2	-	Softmax

Table 15 CRNN model 5.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	Memory Units	# of Neurons	Rate	Activation
2D Convolutional	16	5x5	-	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-	-
Batch Normalization	-	-	-	-	-	-	-
Reshape for LSTM	-	-	-	-	-	-	-
LSTM	-	-	-	32	-	-	-
Flatten	-	-	-	-	-	-	-
Dense	-	-	-	-	32	-	ReLU
Dropout	-	-	-	-	-	0.4	-
Dense (Output)	-	-	-	-	2	-	Softmax

Table 16 CRNN model 6.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	Memory Units	# of Neurons	Rate	Activation
2D Convolutional	8	5x5	-	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-	-
Batch Normalization	-	-	-	-	-	-	-
Reshape for LSTM	-	-	-	-	-	-	-
LSTM	-	-	-	32	-	-	-
Flatten	-	-	-	-	-	-	-
Dense	-	-	-	-	32	-	ReLU
Dropout	-	-	-	-	-	0.3	-
Dense (Output)	-	-	-	-	2	-	Softmax

Table 17 CRNN model 7.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	Memory Units	# of Neurons	Rate	Activation
2D Convolutional	16	5x5	-	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-	-
Batch Normalization	-	-	-	-	-	-	-
Reshape for LSTM	-	-	-	-	-	-	-
LSTM	-	-	-	32	-	-	-
Flatten	-	-	-	-	-	-	-
Dense	-	-	-	-	32	-	ReLU
Dropout	-	-	-	-	-	0.3	-
Dense (Output)	-	-	-	-	2	-	Softmax

Table 18 CRNN model 8.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	Memory Units	# of Neurons	Rate	Activation
2D Convolutional	32	5x5	-	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-	-
Batch Normalization	-	-	-	-	-	-	-
Reshape for LSTM	-	-	-	-	-	-	-
LSTM	-	-	-	64	-	-	-
Flatten	-	-	-	-	-	-	-
Dense	-	-	-	-	64	-	ReLU
Dropout	-	-	-	-	-	0.45	-
Dense (Output)	-	-	-	-	2	-	Softmax

Table 19 CRNN model 9.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	Memory Units	# of Neurons	Rate	Activation
2D Convolutional	8	5x5	-	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-	-
Batch Normalization	-	-	-	-	-	-	-
Reshape for LSTM	-	-	-	-	-	-	-
LSTM	-	-	-	16	-	-	-
Flatten	-	-	-	-	-	-	-
Dense	-	-	-	-	16	-	ReLU
Dropout	-	-	-	-	-	0.15	-
Dense (Output)	-	-	-	-	2	-	Softmax

Table 20 CRNN model 10.

Layer Type	Kernels	Kernel Size	Kernel Stride Size	Memory Units	# of Neurons	Rate	Activation
2D Convolutional	8	5x5	-	-	-	-	ReLU
2D Max Pooling	-	5x5	2	-	-	-	-
Batch Normalization	-	-	-	-	-	-	-
Reshape for LSTM	-	-	-	-	-	-	-
LSTM	-	-	-	32	-	-	-
Flatten	-	-	-	-	-	-	-
Dense	-	-	-	-	32	-	ReLU
Dropout	-	-	-	-	-	0.3	-
Dense (Output)	-	-	-	-	2	-	Softmax