Window size:1024

Stride: 512

Raw data with detrend(lambda:300)

Lowpass filter(400Hz)

Use all channels

No scale on raw signal. Shuffle and split data to 20% for test. Shuffle and split the rest to 80% for training and 20% for validation.

model = keras.models.Sequential()

model.add(layers.InputLayer(input\_shape=X[:,:,:].shape[1:]))

model.add(layers.Bidirectional(layers.LSTM(32,return\_sequences=True,

recurrent\_regularizer=reg)))

model.add(layers.Conv1D(filters=32, kernel\_size=kernel\_size,strides=2,

padding='same',

kernel\_regularizer=reg,

kernel\_initializer=kernel\_initializer))

model.add(layers.BatchNormalization(momentum=0.8))

model.add(layers.ELU())

model.add(layers.Dropout(drop\_rate))

model.add(layers.Conv1D(filters=16, kernel\_size=kernel\_size,strides=2,

padding='same',

kernel\_regularizer=reg,

kernel\_initializer=kernel\_initializer))

model.add(layers.BatchNormalization(momentum=0.8))

model.add(layers.ELU())

model.add(layers.Dropout(drop\_rate))

model.add(layers.Conv1D(filters=8, kernel\_size=kernel\_size,strides=2,

padding='same',

kernel\_regularizer=reg,

kernel\_initializer=kernel\_initializer))

model.add(layers.BatchNormalization(momentum=0.8))

model.add(layers.ELU())

model.add(layers.Dropout(drop\_rate))

model.add(layers.Conv1D(filters=4, kernel\_size=kernel\_size,strides=2,

padding='same',

kernel\_regularizer=reg,

kernel\_initializer=kernel\_initializer))

model.add(layers.BatchNormalization(momentum=0.8))

model.add(layers.ELU())

model.add(layers.GlobalAveragePooling1D())

model.add(layers.Dropout(drop\_rate))

model.add(layers.Dense(3,activation='softmax',kernel\_regularizer=reg))

|  |  |
| --- | --- |
| file | label 1 |
| G07\_Freezing\_Trial1\_trial\_1\_emg.csv | 14 |
| G08\_FoG\_1\_trial\_1\_emg.csv | 52 |
| G08\_FoG\_2\_trial\_1\_emg.csv | 135 |
| P551\_M050\_2\_B\_FoG\_trial\_1\_emg.csv | 15 |
| P812\_M050\_2\_B\_FoG\_trial\_1\_emg.csv | 1 |

kernel\_size=9

reg=regularizers.l2(1e-4)

drop\_rate = 0.2

kernel\_initializer = 'glorot\_uniform'

## drop G07\_Freezing\_Trial1\_trial\_1\_emg.csv and P551\_M050\_2\_B\_FoG\_trial\_1\_emg.csv

no cost sensitive learning and class weights

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 118 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 306 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 183 | 1.000 |

Validation (acc 0.965)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 27 | 2 | 1 | 0.900 |
| Actual 2 | 1 | 106 | 2 | 0.972 |
| Actual 6 | 0 | 1 | 63 | 0.984 |

Test (acc 0.931)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 34 | 4 | 2 | 0.85 |
| Actual 2 | 0 | 96 | 2 | 0.979 |
| Actual 6 | 3 | 3 | 59 | 0.907 |

class weights: 8:1:1

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 118 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 306 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 183 | 1.000 |

Validation (acc 0.950)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 28 | 2 | 0 | 0.933 |
| Actual 2 | 3 | 101 | 5 | 0.926 |
| Actual 6 | 0 | 0 | 64 | 1.000 |

Test (acc 0.925)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 34 | 4 | 2 | 0.850 |
| Actual 2 | 1 | 94 | 3 | 0.959 |
| Actual 6 | 5 | 0 | 59 | 0.921 |

cost sensitive learning

cost\_matrix =

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 118 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 306 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 183 | 1.000 |

Validation (acc 0.950)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 29 | 1 | 0 | 0.966 |
| Actual 2 | 4 | 101 | 4 | 0.926 |
| Actual 6 | 1 | 0 | 63 | 0.984 |

Test (acc 0.935)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 37 | 1 | 2 | 0.925 |
| Actual 2 | 2 | 93 | 3 | 0.948 |
| Actual 6 | 5 | 0 | 60 | 0.923 |

## No file drop

No weights:

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 117 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 306 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 183 | 1.000 |

Validation (acc 0.880)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 35 | 10 | 6 | 0.686 |
| Actual 2 | 5 | 84 | 1 | 0.933 |
| Actual 6 | 2 | 1 | 65 | 0.955 |

Test (acc 0.899)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 39 | 5 | 5 | 0.795 |
| Actual 2 | 4 | 91 | 4 | 0.919 |
| Actual 6 | 1 | 2 | 58 | 0.950 |

Class weights: 8:1:1

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 117 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 324 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 183 | 1.000 |

Validation (acc 0.870)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 37 | 10 | 4 | 0.725 |
| Actual 2 | 8 | 81 | 1 | 0.900 |
| Actual 6 | 3 | 1 | 64 | 0.941 |

Test (acc 0.913)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 40 | 5 | 4 | 0.816 |
| Actual 2 | 4 | 95 | 0 | 0.959 |
| Actual 6 | 3 | 2 | 56 | 0.918 |

Class weights: 10:1:1

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 117 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 324 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 183 | 1.000 |

Validation (acc 0.918)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 41 | 6 | 4 | 0.803 |
| Actual 2 | 4 | 85 | 1 | 0.944 |
| Actual 6 | 1 | 1 | 66 | 0.970 |

Test (acc 0.904)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 41 | 4 | 4 | 0.836 |
| Actual 2 | 4 | 91 | 4 | 0.919 |
| Actual 6 | 2 | 2 | 57 | 0.934 |

cost sensitive learning

cost\_matrix =

Train (acc 0.998)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 117 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 324 | 0 | 1.000 |
| Actual 6 | 1 | 0 | 182 | 0.994 |

Validation (acc 0.885)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 43 | 5 | 3 | 0.843 |
| Actual 2 | 7 | 75 | 8 | 0.833 |
| Actual 6 | 1 | 0 | 67 | 0.985 |

Test (acc 0.880)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 41 | 3 | 5 | 0.836 |
| Actual 2 | 5 | 85 | 9 | 0.858 |
| Actual 6 | 1 | 2 | 58 | 0.950 |

## Drop G07\_Freezing\_Trial1\_trial\_1\_emg.csv

No weights

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 127 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 298 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 191 | 1.000 |

Validation (acc 0.936)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 24 | 9 | 0 | 0.727 |
| Actual 2 | 2 | 117 | 1 | 0.975 |
| Actual 6 | 1 | 0 | 52 | 0.981 |

Test (acc 0.912)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 33 | 9 | 1 | 0.767 |
| Actual 2 | 1 | 93 | 1 | 0.978 |
| Actual 6 | 5 | 1 | 62 | 0.911 |

Class weights: 5:1:1

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 127 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 298 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 191 | 1.000 |

Validation (acc 0.936)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 25 | 7 | 1 | 0.757 |
| Actual 2 | 1 | 117 | 2 | 0.975 |
| Actual 6 | 1 | 1 | 51 | 0.962 |

Test (acc 0.912)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 35 | 6 | 2 | 0.813 |
| Actual 2 | 1 | 91 | 3 | 0.957 |
| Actual 6 | 3 | 3 | 62 | 0.911 |

Class weights: 10:1:1

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 127 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 298 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 191 | 1.000 |

Validation (acc 0.927)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 27 | 6 | 0 | 0.818 |
| Actual 2 | 4 | 114 | 2 | 0.950 |
| Actual 6 | 2 | 1 | 50 | 0.943 |

Test (acc 0.902)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 36 | 6 | 1 | 0.837 |
| Actual 2 | 5 | 89 | 1 | 0.936 |
| Actual 6 | 6 | 1 | 61 | 0.897 |

Cost sensitive learning:

cost\_matrix =

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 127 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 298 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 191 | 1.000 |

Validation (acc 0.917)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 28 | 3 | 2 | 0.848 |
| Actual 2 | 5 | 111 | 4 | 0.925 |
| Actual 6 | 2 | 1 | 50 | 0.943 |

Test (acc 0.907)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 38 | 5 | 0 | 0.883 |
| Actual 2 | 6 | 87 | 2 | 0.915 |
| Actual 6 | 6 | 0 | 62 | 0.911 |

cost\_matrix =

Train (acc 1,000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 127 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 298 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 191 | 1.000 |

Validation (acc 0.946)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 31 | 2 | 0 | 0.939 |
| Actual 2 | 4 | 114 | 2 | 0.950 |
| Actual 6 | 2 | 1 | 50 | 0.943 |

Test (acc 0.893)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 34 | 7 | 2 | 0.790 |
| Actual 2 | 4 | 90 | 1 | 0.947 |
| Actual 6 | 8 | 0 | 60 | 0.882 |

## P551\_M050\_2\_B\_FoG\_trial\_1\_emg.csv

No weights

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 120 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 299 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 196 | 1.000 |

Validation (acc 0.941)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 34 | 3 | 3 | 0.850 |
| Actual 2 | 2 | 110 | 1 | 0.973 |
| Actual 6 | 2 | 1 | 50 | 0.943 |

Test (acc 0.912)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 35 | 6 | 1 | 0.833 |
| Actual 2 | 4 | 95 | 2 | 0.940 |
| Actual 6 | 2 | 3 | 58 | 0.920 |

Class weights: 10:1:1

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 120 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 299 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 196 | 1.000 |

Validation (acc 0.941)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 35 | 2 | 3 | 0.875 |
| Actual 2 | 3 | 110 | 0 | 0.973 |
| Actual 6 | 3 | 1 | 49 | 0.924 |

Test (acc 0.941)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 40 | 2 | 0 | 0.952 |
| Actual 2 | 4 | 96 | 1 | 0.950 |
| Actual 6 | 5 | 0 | 58 | 0.920 |

Cost sensitive learning:

cost\_matrix =

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 120 | 0 | 0 | 1.000 |
| Actual 2 | 0 | 299 | 0 | 1.000 |
| Actual 6 | 0 | 0 | 196 | 1.000 |

Validation (acc 0.902)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 34 | 3 | 3 | 0.850 |
| Actual 2 | 6 | 107 | 0 | 0.946 |
| Actual 6 | 5 | 3 | 45 | 0.849 |

Test (acc 0.893)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 | acc |
| Actual 1 | 39 | 2 | 1 | 0.928 |
| Actual 2 | 7 | 92 | 2 | 0.910 |
| Actual 6 | 7 | 3 | 53 | 0.841 |