Use rectified signals. (rectify\_emg\_moving\_average(X,20))

use cost sensitive learning(1:10) for binary classification(0:others)

drop some files out for test. Shuffle and split the rest data as 75% for training and 25% for validation.

Model consists of rnn and conv1d neural network.

## Drop Files[6,30,31,32,33,34,35]:

Class 0 : others

Train (acc 0.992)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 5516 | 46 |
| Actual others | 0 | 525 |

Valid (acc 0.984)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 1808 | 32 |
| Actual others | 0 | 190 |

Test (acc 0.916)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 286 | 40 |
| Actual others | 4 | 197 |

Class 1 : 2 : 6

Train (acc 1.000)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 122 | 0 | 0 |
| Actual 2 | 0 | 257 | 0 |
| Actual 6 | 0 | 0 | 156 |

Valid (acc 0.899)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 24 | 2 | 5 |
| Actual 2 | 4 | 92 | 2 |
| Actual 6 | 2 | 3 | 45 |

Test (acc 0.597)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 24 | 19 | 9 |
| Actual 2 | 18 | 39 | 0 |
| Actual 6 | 31 | 4 | 57 |

Class 2 : 6

Train (acc 0.985)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 253 | 6 |
| Actual 6 | 0 | 161 |

Valid (acc 0.964)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 93 | 3 |
| Actual 6 | 2 | 43 |

Test (acc 0.966)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 56 | 1 |
| Actual 6 | 4 | 88 |

Class 1 : 6

Train (acc 1.000)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 122 | 0 |
| Actual 6 | 0 | 147 |

Valid (acc 0.944)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 27 | 4 |
| Actual 6 | 1 | 58 |

Test (acc 0.833)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 46 | 6 |
| Actual 6 | 18 | 74 |

Class 1 : 2

Train (acc 0.997)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 121 | 0 |
| Actual 2 | 1 | 259 |

Valid (acc 0.913)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 25 | 7 |
| Actual 2 | 4 | 91 |

Test (acc 0.779)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 34 | 18 |
| Actual 2 | 6 | 51 |

## Drop Files[7,30,31,32,33,34,35]:

Class 0 : others

Train (acc 0.993)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 5558 | 41 |
| Actual others | 0 | 437 |

Valid (acc 0.987)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 1833 | 20 |
| Actual others | 5 | 154 |

Test (acc 0.969)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 272 | 4 |
| Actual others | 14 | 306 |

Class 1 : 2 : 6

Train (acc 1.000)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 64 | 0 | 0 |
| Actual 2 | 0 | 232 | 0 |
| Actual 6 | 0 | 0 | 151 |

Valid (acc 0.926)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 9 | 4 | 2 |
| Actual 2 | 1 | 92 | 2 |
| Actual 6 | 2 | 0 | 37 |

Test (acc 0.655)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 49 | 26 | 51 |
| Actual 2 | 17 | 60 | 8 |
| Actual 6 | 5 | 3 | 100 |

Class 2 : 6

Train (acc 0.981)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 239 | 5 |
| Actual 6 | 2 | 141 |

Valid (acc 0.953)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 79 | 4 |
| Actual 6 | 2 | 45 |

Test (acc 0.932)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 73 | 12 |
| Actual 6 | 1 | 107 |

Class 1 : 6

Train (acc 1.000)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 59 | 0 |
| Actual 6 | 0 | 142 |

Valid (acc 0.955)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 19 | 1 |
| Actual 6 | 2 | 46 |

Test (acc 0.739)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 65 | 61 |
| Actual 6 | 0 | 108 |

Class 1 : 2

Train (acc 0.993)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 56 | 2 |
| Actual 2 | 0 | 246 |

Valid (acc 0.882)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 13 | 8 |
| Actual 2 | 4 | 77 |

Test (acc 0.779)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 106 | 20 |
| Actual 2 | 28 | 57 |

## Drop Files[5,30,31,32,33,34,35]:

Class 0 : others

Train (acc 0.993)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 5511 | 60 |
| Actual others | 0 | 591 |

Valid (acc 0.987)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 1821 | 25 |
| Actual others | 8 | 201 |

Test (acc 0.969)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 301 | 10 |
| Actual others | 12 | 104 |

Class 1 : 2 : 6

Train (acc 1.000)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 146 | 0 | 0 |
| Actual 2 | 0 | 297 | 0 |
| Actual 6 | 0 | 0 | 156 |

Valid (acc 0.905)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 38 | 3 | 5 |
| Actual 2 | 4 | 100 | 2 |
| Actual 6 | 4 | 1 | 43 |

Test (acc 0.344)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 2 | 11 | 51 |
| Actual 2 | 1 | 7 | 1 |
| Actual 6 | 30 | 33 | 31 |

Class 2 : 6

Train (acc 0.997)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 291 | 1 |
| Actual 6 | 0 | 163 |

Valid (acc 0.986)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 109 | 2 |
| Actual 6 | 0 | 41 |

Test (acc 0.572)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 8 | 1 |
| Actual 6 | 43 | 51 |

Class 1 : 6

Train (acc 1.000)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 145 | 0 |
| Actual 6 | 0 | 152 |

Valid (acc 0.909)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 40 | 7 |
| Actual 6 | 2 | 50 |

Test (acc 0.439)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 13 | 0 |
| Actual 6 | 60 | 34 |

Class 1 : 2

Train (acc 1.000)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 152 | 0 |
| Actual 2 | 0 | 294 |

Valid (acc 0.892)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 34 | 6 |
| Actual 2 | 10 | 99 |

Test (acc 0.409)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 2 | 11 |
| Actual 2 | 2 | 7 |

## Model:

kernel\_size=3

reg=regularizers.l2(1e-4)

drop\_rate = 0.

kernel\_initializer = 'glorot\_normal'

mo = 0.8

st = 1

axis = 2

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=st,

padding='same',

kernel\_regularizer=reg,

))

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

model.add(layers.LeakyReLU(0.1))

model.add(layers.MaxPooling1D(2))

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

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

strides=st,

padding='same',

kernel\_regularizer=reg,

))

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

model.add(layers.LeakyReLU(0.1))

model.add(layers.MaxPooling1D(2))

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

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

strides=st,

padding='same',

kernel\_regularizer=reg,

))

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

model.add(layers.LeakyReLU(0.1))

model.add(layers.MaxPooling1D(2))

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

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

strides=st,

padding='same',

kernel\_regularizer=reg,

))

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

model.add(layers.LeakyReLU(0.1))

model.add(layers.MaxPooling1D(2))

model.add(layers.GlobalAveragePooling1D())

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

model.add(layers.Dense(2,activation='softmax',kernel\_regularizer=reg))