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. No shuffle and split the rest data as 80% for training and 20% for validation.

Model consists of rnn and conv1d neural network.

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

Class 0 : others

Train (acc 0.989)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 5789 | 69 |
| Actual others | 0 | 562 |

Valid (acc 0.960)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 1482 | 62 |
| Actual others | 5 | 148 |

Test (acc 0.918)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 285 | 41 |
| Actual others | 2 | 199 |

Class 1 : 2 : 6

Train (acc 0.962)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 111 | 1 | 8 |
| Actual 2 | 6 | 267 | 5 |
| Actual 6 | 1 | 0 | 163 |

Valid (acc 0.736)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 10 | 13 | 10 |
| Actual 2 | 1 | 71 | 5 |
| Actual 6 | 6 | 5 | 31 |

Test (acc 0.781)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 34 | 8 | 10 |
| Actual 2 | 10 | 45 | 2 |
| Actual 6 | 14 | 0 | 78 |

Class 2 : 6

Train (acc 0.984)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 271 | 7 |
| Actual 6 | 0 | 164 |

Valid (acc 0.899)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 71 | 6 |
| Actual 6 | 6 | 36 |

Test (acc 0.959)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 52 | 5 |
| Actual 6 | 1 | 91 |

Class 1 : 6

Train (acc 0.883)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 90 | 30 |
| Actual 6 | 3 | 161 |

Valid (acc 0.693)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 19 | 14 |
| Actual 6 | 9 | 33 |

Test (acc 0.902)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 45 | 7 |
| Actual 6 | 7 | 85 |

Class 1 : 2

Train (acc 0.904)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 116 | 4 |
| Actual 2 | 34 | 244 |

Valid (acc 0.863)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 24 | 9 |
| Actual 2 | 6 | 71 |

Test (acc 0.724)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 50 | 2 |
| Actual 2 | 28 | 29 |

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

Class 0 : others

Train (acc 0.986)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 5815 | 83 |
| Actual others | 2 | 465 |

Valid (acc 0.954)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 1492 | 62 |
| Actual others | 14 | 115 |

Test (acc 0.959)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 265 | 11 |
| Actual others | 13 | 307 |

Class 1 : 2 : 6

Train (acc 1.000)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 23 | 16 | 22 |
| Actual 2 | 0 | 247 | 8 |
| Actual 6 | 0 | 0 | 151 |

Valid (acc 0.926)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 1 | 9 | 8 |
| Actual 2 | 0 | 69 | 3 |
| Actual 6 | 2 | 5 | 32 |

Test (acc 0.655)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 3 | 48 | 75 |
| Actual 2 | 0 | 66 | 19 |
| Actual 6 | 0 | 0 | 108 |

Class 2 : 6

Train (acc 0.997)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 254 | 1 |
| Actual 6 | 0 | 151 |

Valid (acc 0.891)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 69 | 3 |
| Actual 6 | 9 | 30 |

Test (acc 0.906)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 68 | 17 |
| Actual 6 | 1 | 107 |

Class 1 : 6

Train (acc 1.000)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 61 | 0 |
| Actual 6 | 0 | 151 |

Valid (acc 0.807)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 15 | 3 |
| Actual 6 | 8 | 31 |

Test (acc 0.756)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 72 | 54 |
| Actual 6 | 3 | 105 |

Class 1 : 2

Train (acc 1.000)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 61 | 0 |
| Actual 2 | 0 | 255 |

Valid (acc 0.900)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 11 | 7 |
| Actual 2 | 2 | 70 |

Test (acc 0.668)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 91 | 35 |
| Actual 2 | 35 | 50 |

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

Class 0 : others

Train (acc 0.977)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 5724 | 146 |
| Actual others | 0 | 629 |

Valid (acc 0.929)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 1433 | 114 |
| Actual others | 7 | 164 |

Test (acc 0.918)

|  |  |  |
| --- | --- | --- |
|  | Predicted 0 | Predicted others |
| Actual 0 | 283 | 28 |
| Actual others | 7 | 109 |

Class 1 : 2 : 6

Train (acc 0.890)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 94 | 32 | 25 |
| Actual 2 | 6 | 305 | 5 |
| Actual 6 | 1 | 0 | 161 |

Valid (acc 0.788)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 10 | 18 | 13 |
| Actual 2 | 1 | 86 | 0 |
| Actual 6 | 2 | 2 | 38 |

Test (acc 0.370)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 6 |
| Actual 1 | 0 | 13 | 0 |
| Actual 2 | 2 | 6 | 1 |
| Actual 6 | 22 | 35 | 37 |

Class 2 : 6

Train (acc 0.997)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 315 | 1 |
| Actual 6 | 0 | 162 |

Valid (acc 0.976)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 86 | 1 |
| Actual 6 | 2 | 40 |

Test (acc 0.553)

|  |  |  |
| --- | --- | --- |
|  | Predicted 2 | Predicted 6 |
| Actual 2 | 8 | 1 |
| Actual 6 | 45 | 49 |

Class 1 : 6

Train (acc 0.920)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 141 | 10 |
| Actual 6 | 15 | 147 |

Valid (acc 0.843)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 31 | 10 |
| Actual 6 | 3 | 39 |

Test (acc 0.327)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 6 |
| Actual 1 | 13 | 0 |
| Actual 6 | 72 | 22 |

Class 1 : 2

Train (acc 0.937)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 148 | 3 |
| Actual 2 | 26 | 290 |

Valid (acc 0.882)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 30 | 11 |
| Actual 2 | 4 | 83 |

Test (acc 0.318)

|  |  |  |
| --- | --- | --- |
|  | Predicted 1 | Predicted 2 |
| Actual 1 | 0 | 13 |
| 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))