

First DL for COSINE

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Data Selection

- Signal waveform is obtained from calibration run 1601, 1765.
 - Selected events having coincidence with LS or other crystals, with basic pre-cut.
- Background waveform is obtained from physics run 1858.
 - Selected single events, with basic pre-cut.

Data Statistics

Runnum	1	2	3	4	6	7
1765 (Sig)	1864	3478	5531	2640	7261	8049
1858 (Bkg)	1151944	891598	1219143	1342570	1047218	1184431
Ratio [%] (Sig/Total)	0.32	0.77	0.90	0.39	1.37	1.34

※ Note that run 1601 has similar number of signals with 1765.

※ I trained for crystal 3.

Layer

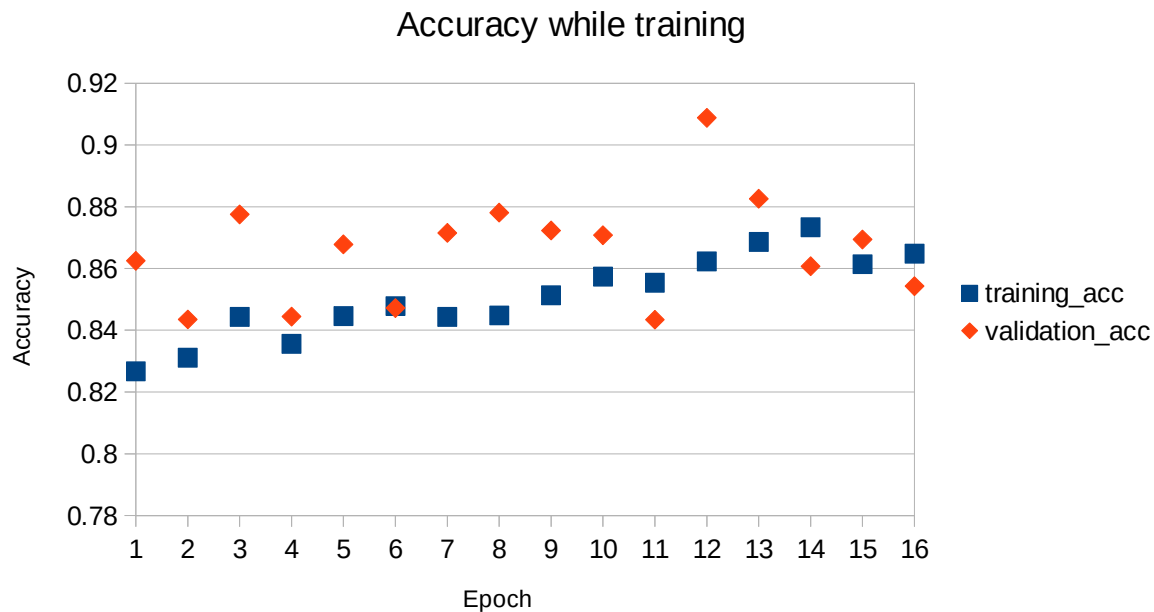
Layer (type)	Output Shape	Param #
=====		
reshape_1 (Reshape)	(None, 8160)	0
dense_1 (Dense)	(None, 768)	6267648
activation_1 (Activation)	(None, 768)	0
dropout_1 (Dropout)	(None, 768)	0
dense_2 (Dense)	(None, 512)	393728
activation_2 (Activation)	(None, 512)	0
dropout_2 (Dropout)	(None, 512)	0
dense_3 (Dense)	(None, 512)	262656
activation_3 (Activation)	(None, 512)	0
dropout_3 (Dropout)	(None, 512)	0
dense_4 (Dense)	(None, 512)	262656
activation_4 (Activation)	(None, 512)	0
dropout_4 (Dropout)	(None, 512)	0
dense_5 (Dense)	(None, 2)	1026
activation_5 (Activation)	(None, 2)	0
=====		
Total params: 7,187,714		

- 4 hidden dense layers
- Dropout 0.25~0.3
- ReLU activation

Training

- Optimizer: Adam
- Epochs: 60
- `class_weights` was set. Signal and background were considered to be equally important.

Training Result



Test Result

- Test was done using 4407 events.
 - ~2000 signals and ~2000 backgrounds.
- Test accuracy: 0.8563648462295532
- Efficiency for background : 86.140277 %
- Efficiency for signal : 85.044423 %

Plan

- Try lots of hyper parameters.
 - First, I will focus on Dense layer only.
- Try dropout, batch normalization.
 - Batch normalization: normalize input data. It prohibits over-fitting, initialization problem, and accelerates learning speed.
- Observe accuracy distribution in energy.
 - Observe waveform case-by-case, if needed.