Lab 4-1 EEG classification

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Important Rules

Important Date :

- Report Submission Deadline: 4/12 (Tue) 11:59 a.m.
- Demo date: 4/12 (Tue)

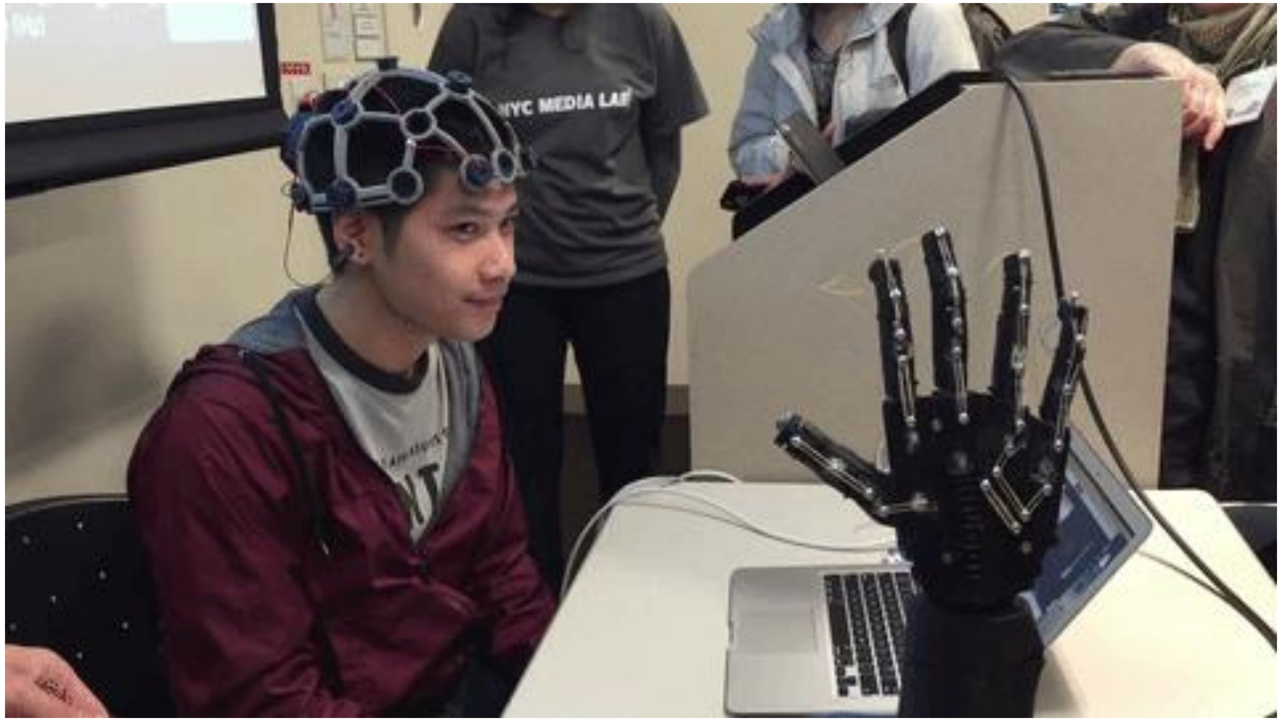
Turn in :

- Experiment Report (.pdf)
- Source code (.py)

Notice: zip all files in one file and name it like「DLP_LAB4-1_your studentID_name.zip」, ex: 「DLP_LAB4-1_309553005_賴佑家_.zip」

Lab Objective

- In this lab, you will need to implement simple EEG classification models which are EEGNet, DeepConvNet[1] with BCI competition dataset. Additionally, you need to try different kinds of activation function including 『ReLU』, 『Leaky ReLU』, 『ELU』.



Requirements

- Implement the EEGNet, DeepConvNet with three kinds of activation function including 『ReLU』, 『Leaky ReLU』, 『ELU』.

- In the experiment results, you have to show the highest accuracy (not loss) of two architectures with three kinds of activation functions.

- To visualize the accuracy trend, you need to plot each epoch accuracy (not loss) during training phase and testing phase.

Dataset

- BCI Competition III – IIIb
- [2 classes, 2 bipolar EEG channels]
- *Reference: http://www.bbci.de/competition/iii/desc_IIIb.pdf*

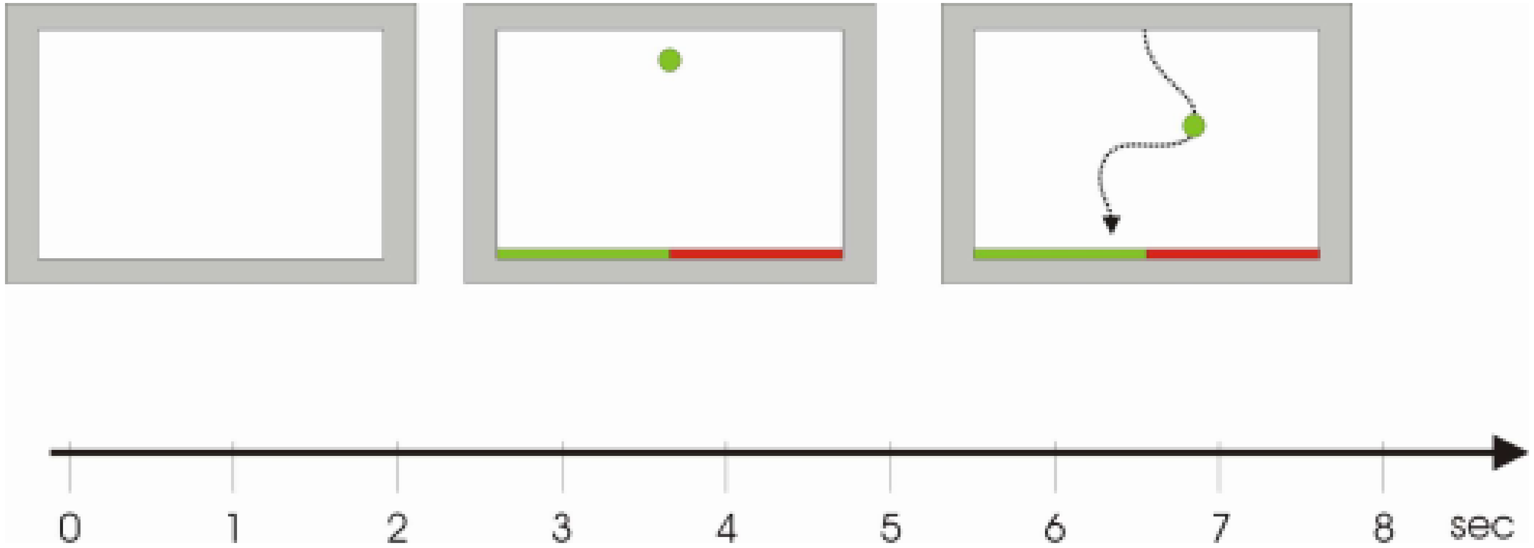


Figure 3: Basket paradigm used for S4 and X11 [3].

Prepare Data

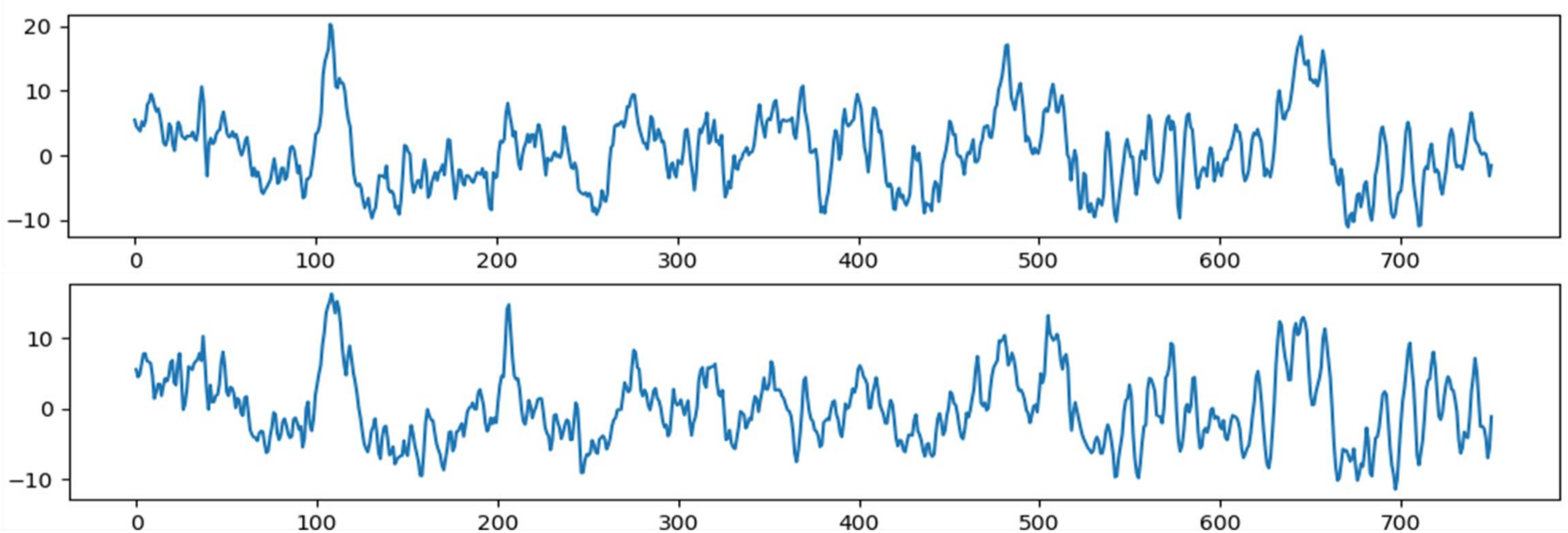
- Training data: S4b_train.npz, X11b_train.npz
- Testing data: S4b_test.npz, X11b_test.npz
- To read the preprocessed data, refer to the "dataloader.py".

B: batch size

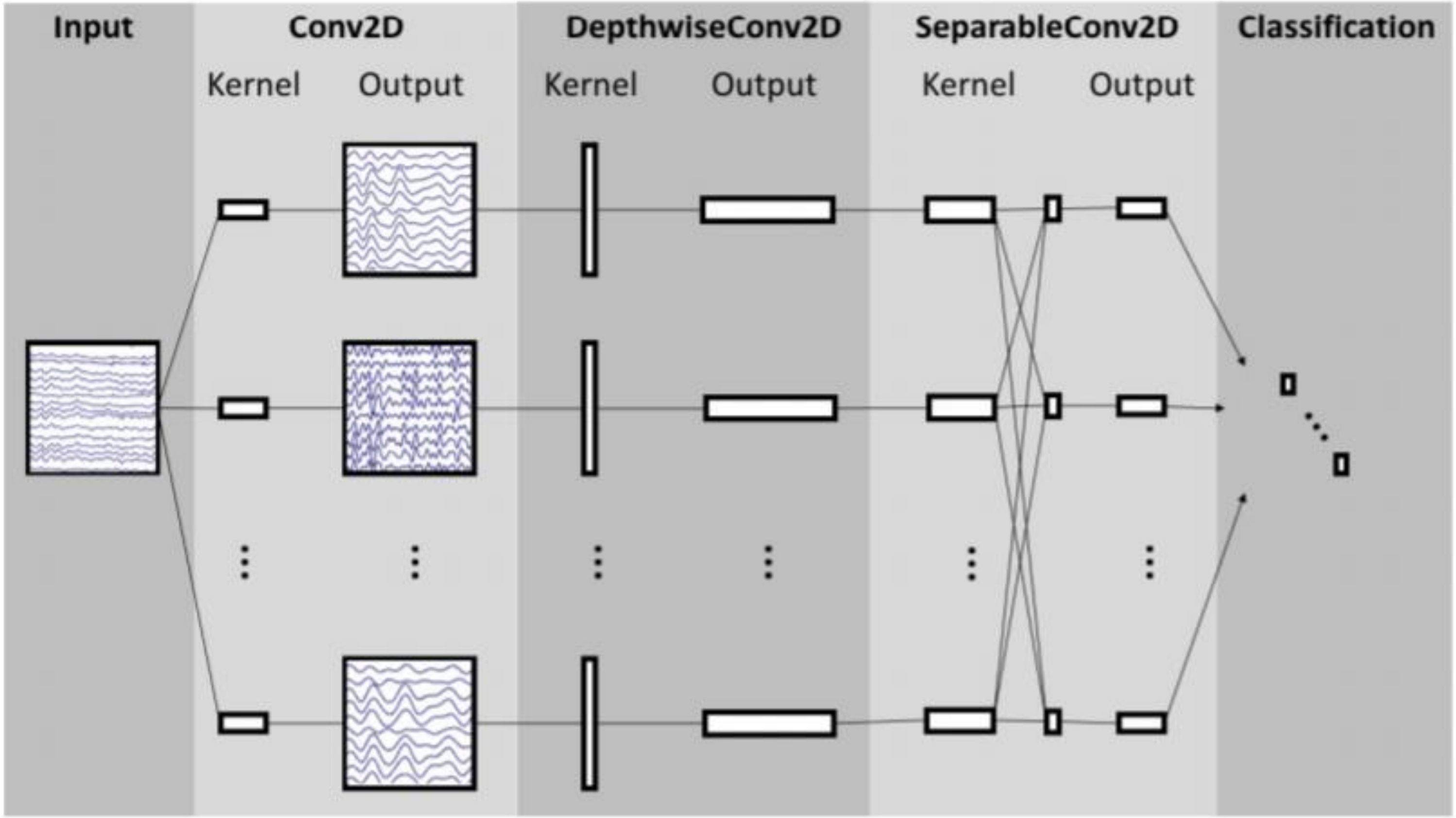
- **Input: [B, 1, 2, 750]　　Output: [B, 2]　　Ground truth: [B]**

Channel 1

Channel 2



Create Model - EEGNet



Reference: Depthwise Separable Convolution

https://towardsdatascience.com/a-basic-introduction-to-separable-convolutions-b99ec3102728

Create Model - EEGNet

- EEGNet implementation details

```
EEGNet(
  (firstconv): Sequential(
    (0): Conv2d(1, 16, kernel_size=(1, 51), stride=(1, 1), padding=(0, 25), bias=False)
    (1): BatchNorm2d(16, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  )
  (depthwiseConv): Sequential(
    (0): Conv2d(16, 32, kernel_size=(2, 1), stride=(1, 1), groups=16, bias=False)
    (1): BatchNorm2d(32, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): ELU(alpha=1.0)
    (3): AvgPool2d(kernel_size=(1, 4), stride=(1, 4), padding=0)
    (4): Dropout(p=0.25)
  )
  (separableConv): Sequential(
    (0): Conv2d(32, 32, kernel_size=(1, 15), stride=(1, 1), padding=(0, 7), bias=False)
    (1): BatchNorm2d(32, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): ELU(alpha=1.0)
    (3): AvgPool2d(kernel_size=(1, 8), stride=(1, 8), padding=0)
    (4): Dropout(p=0.25)
  )
  (classify): Sequential(
    (0): Linear(in_features=736, out_features=2, bias=True)
  )
)
```

Create Model - DeepConvNet

- You need to implement the DeepConvNet architecture by using the following table, where C = 2, T = 750 and N = 2. **The max norm term is ignorable.**

Layer	# filters	size	# params	Activation	Options
Input		(C, T)			
Reshape		(1, C, T)			
Conv2D	25	(1, 5)	150	Linear	mode = valid, max norm = 2
Conv2D	25	(C, 1)	25 * 25 * C + 25	Linear	mode = valid, max norm = 2
BatchNorm			2 * 25		epsilon = 1e-05, momentum = 0.1
Activation				ELU	
MaxPool2D		(1, 2)			
Dropout					p = 0.5
Conv2D	50	(1, 5)	25 * 50 * 5 + 50	Linear	mode = valid, max norm = 2
BatchNorm			2 * 50		epsilon = 1e-05, momentum = 0.1
Activation				ELU	
MaxPool2D		(1, 2)			
Dropout					p = 0.5
Conv2D	100	(1, 5)	50 * 100 * 5 + 100	Linear	mode = valid, max norm = 2
BatchNorm			2 * 100		epsilon = 1e-05, momentum = 0.1
Activation				ELU	
MaxPool2D		(1, 2)			
Dropout					p = 0.5
Conv2D	200	(1, 5)	100 * 200 * 5 + 200	Linear	mode = valid, max norm = 2
BatchNorm			2 * 200		epsilon = 1e-05, momentum = 0.1
Activation				ELU	
MaxPool2D		(1, 2)			
Dropout					p = 0.5
Flatten					
Dense	N			softmax	max norm = 0.5

The input data has reshaped to [B, 1, C, T]

Create Model - Activation Functions

- In the PyTorch framework, it is easy to implement the activation function.

```
nn.LeakyReLU(),
nn.ReLU(),
nn.ELU(),
```

```
EEGNet(
  (firstconv): Sequential(
    (0): Conv2d(1, 16, kernel_size=(1, 51), stride=(1, 1), padding=(0, 25), bias=False)
    (1): BatchNorm2d(16, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  )
  (depthwiseConv): Sequential(
    (0): Conv2d(16, 32, kernel_size=(2, 1), stride=(1, 1), groups=16, bias=False)
    (1): BatchNorm2d(32, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): ELU(alpha=1.0)
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  )
  (separableConv): Sequential(
    (0): Conv2d(32, 32, kernel_size=(1, 15), stride=(1, 1), padding=(0, 7), bias=False)
    (1): BatchNorm2d(32, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
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  (classify): Sequential(
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  )
)
```

Hyper Parameters

- Batch size= 64
- Learning rate = 1e-2
- Epochs = 150
- Optimizer: Adam
- Loss function: torch.nn.CrossEntropyLoss()

- **You can adjust the hyper-parameters according to your own ideas.**

- If you use “nn.CrossEntropyLoss”, don’t add softmax after final fc layer because this criterion combines LogSoftMax and NLLLoss in one single class.

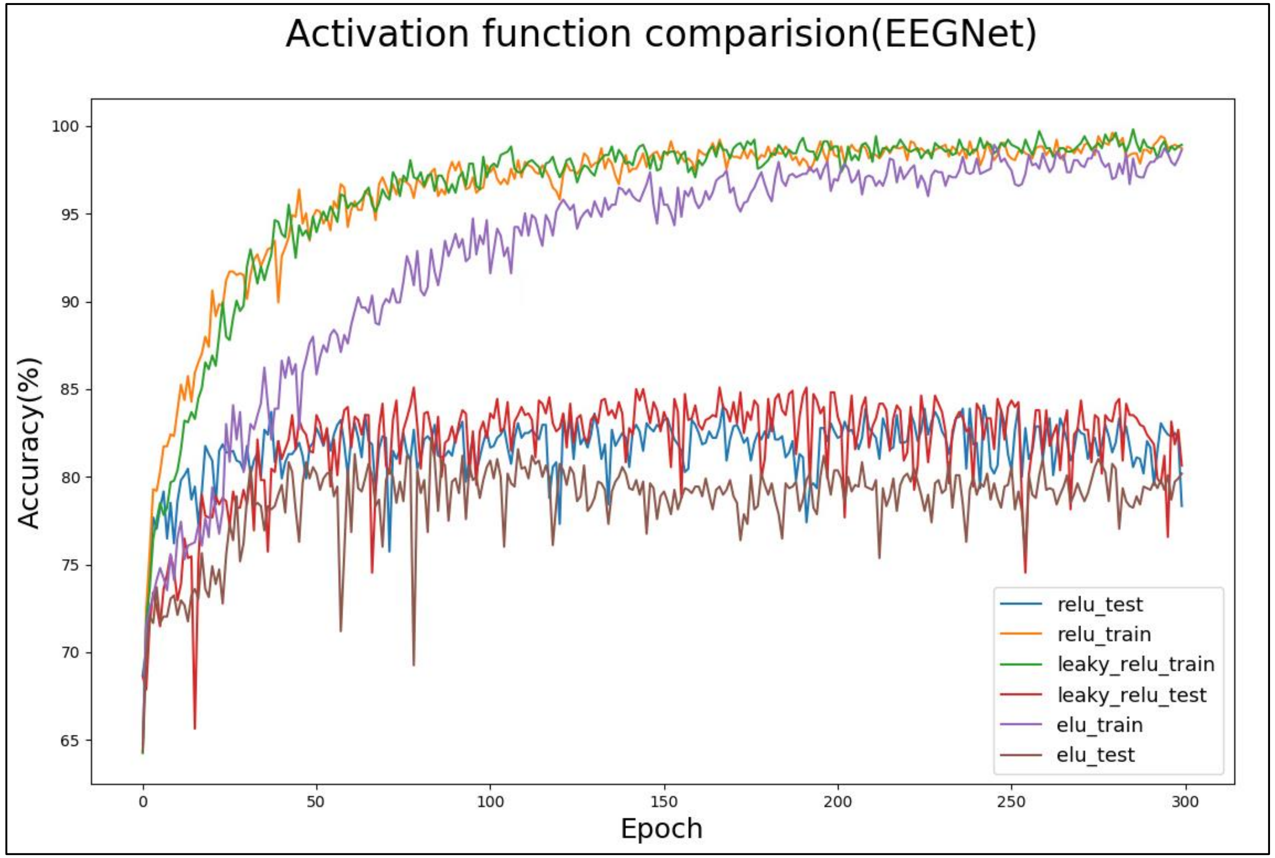
Result Comparison

- You have to show the highest accuracy (not loss) of two architectures with three kinds of activation functions.

	ReLU	Leaky ReLU	ELU
EEGNet	**85.33%**	84.63%	82.93%
DeepConvNet	82.75%	**86.33%**	**85.73%**

Result Comparison

- To visualize the accuracy trend, you need to plot each epoch accuracy (not loss) during training phase and testing phase.
- In this part, you can use the matplotlib library to draw the graph.



Report Spec

1. Introduction (20%)
2. Experiment set up (30%)
   A. The detail of your model
      - EEGNet
      - DeepConvNet
   B. Explain the activation function (ReLU, Leaky ReLU, ELU)
3. Experimental results (30%)
   A. The highest testing accuracy
      - Screenshot with two models
      - anything you want to present
   B. Comparison figures
      - EEGNet
      - DeepConvNet
4. Discussion (20%)
   A. Anything you want to share

- ---- Criterion of result (40%) ----
- Accuracy > = 87% = 100 pts
- Accuracy 85~87% = 90 pts
- Accuracy 80~85% = 80 pts
- Accuracy 75~80% = 70 pts
- Accuracy < 75% = 60 pts

- **Score: 40% accuracy results + 60% (report+ demo score)**
- **P.S If the zip file name or the report spec have format error, it will be penalty (-5).**

Reference

[1] EEGNet: A Compact Convolutional Neural Network for EEG-based Brain-Computer Interfaces