Motor-Imagery Classification

Donghee-ko
donghee-ko@korea.ac.kr

Department of Artificial Intelligence
Korea University

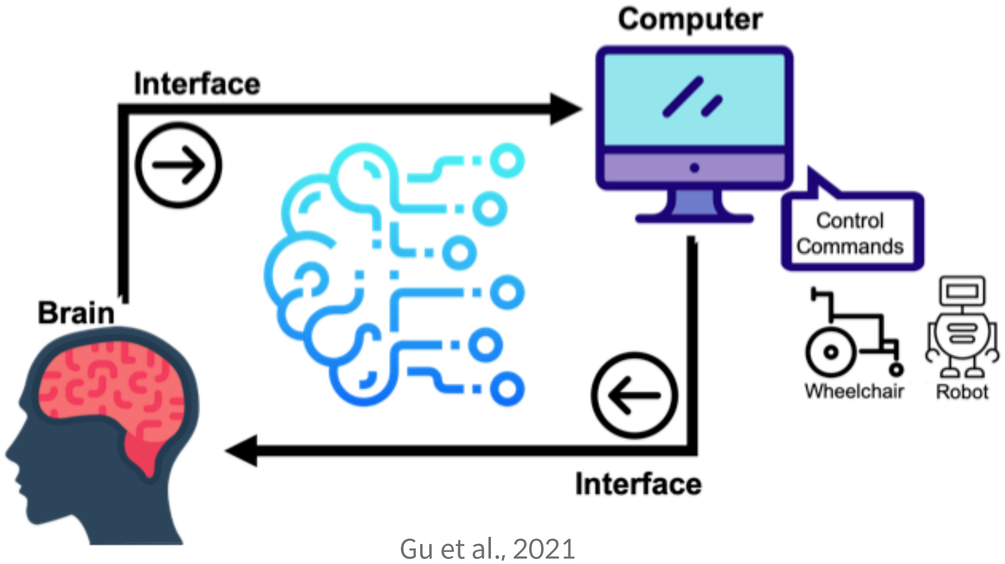
MAI Lab
EDICAL

01

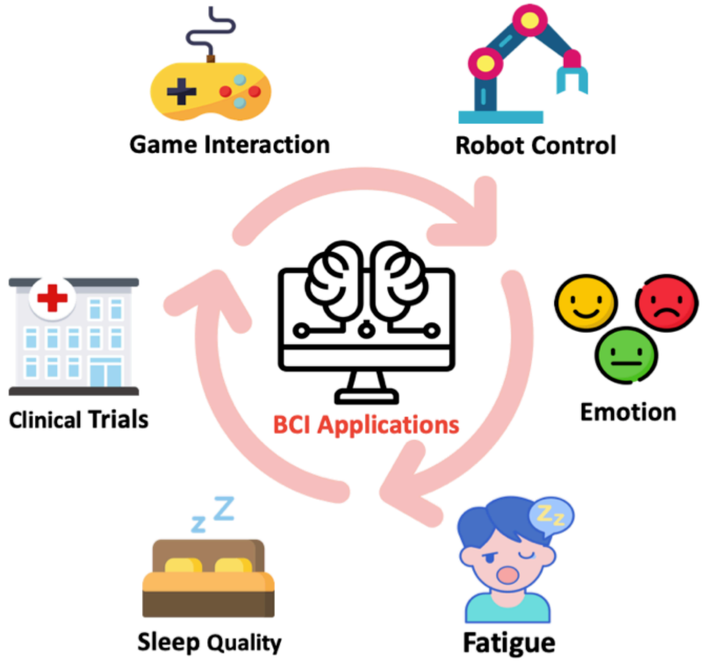
Introduction

What is Brain-Computer Interface?

- Brain-Computer Interface (BCI) is a **technology that enables people to communicate with external devices** by using human brain signals.
- **Electroencephalography (EEG) signals**, which measure the brain waves from a human scalp, are typically used due to portable, non-invasive, and cost-effective advantage.



Gu et al., 2021

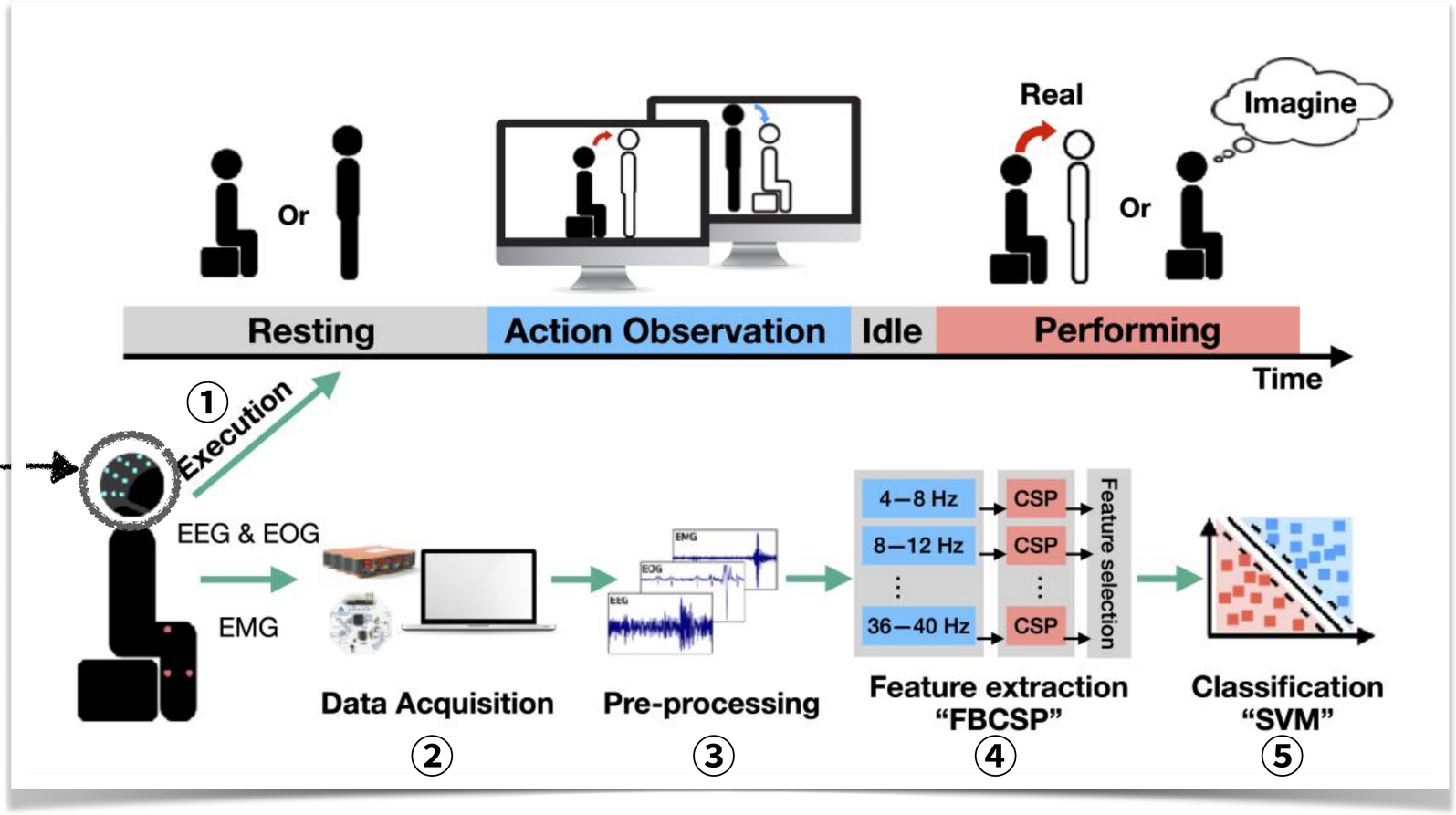


Gu et al., 2021

Motor-Imagery BCI (MI-BCI)

- Motor imagery electroencephalography (MI-EEG) signals are generated **when a person imagines a task without actually performing it.**

EEG cap



Overview of MI-BCI

Applications

- Robotic arms
- Self driving
- Lying on the bed and turning off the lights
- Everything you imagine

Minority Report

Goal

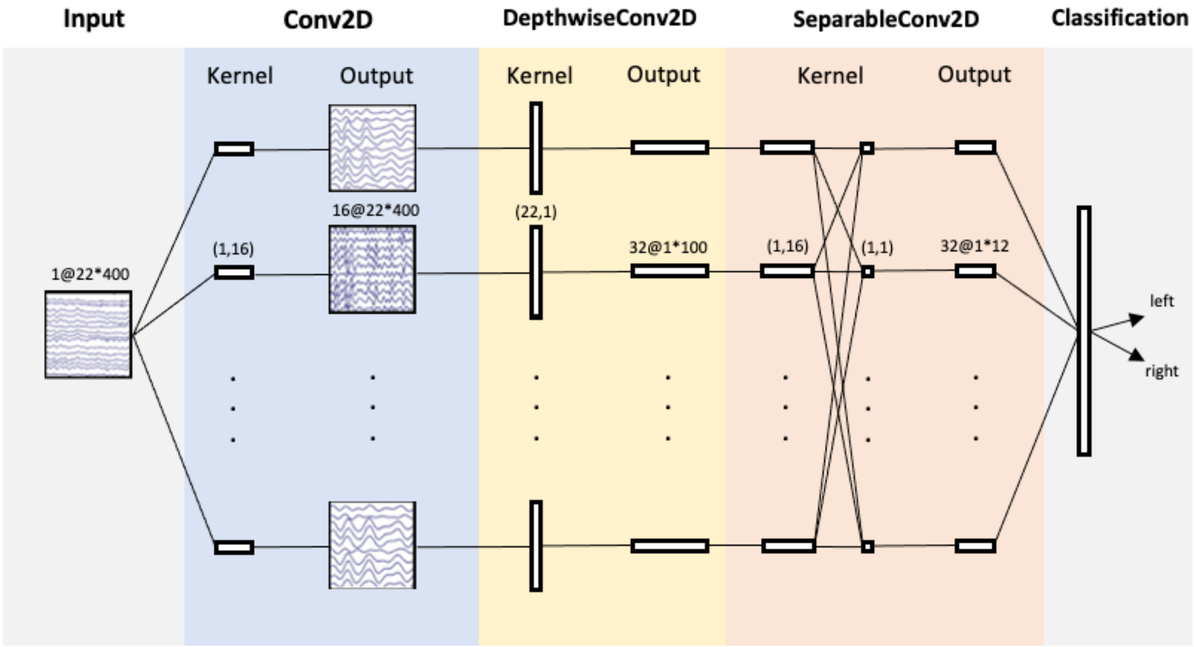
- Improve motor-imagery classification accuracy

02

Related works

EEGNet (Lawhern et al., Journal of Neural Engineering, 2018)

- EEGNet consists of **three convolution blocks**.
- The first convolution block applies **convolution** in the **temporal domain**.
  Each kernel derives a feature map of the band-pass frequencies.
- The second convolution block employs a **depthwise convolution** in the **spatial domain**,
  which extract frequency-specific spatial features for each feature map.
- The third convolution block uses a **separable convolution**.

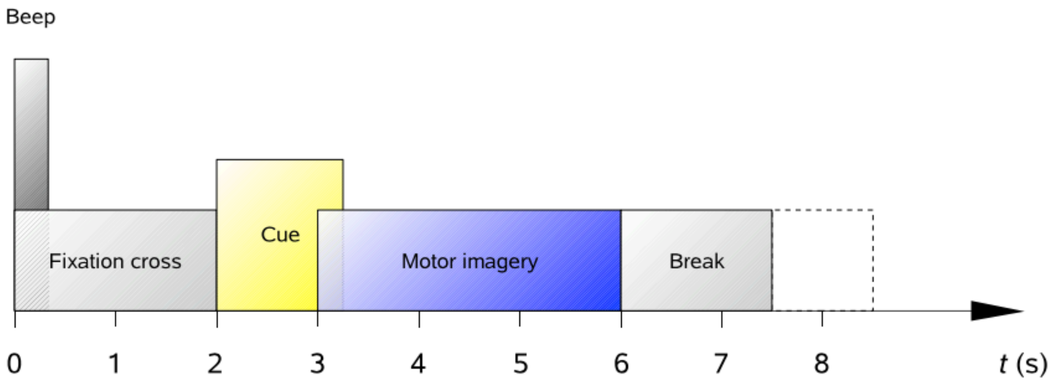


03

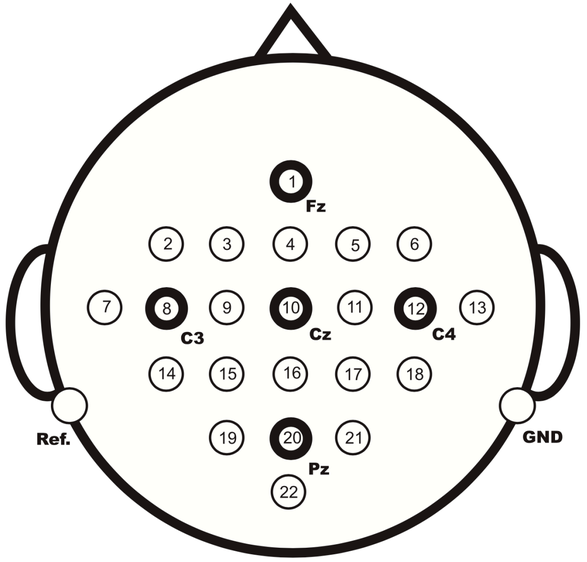
Dataset

MI-BCI data

- 1 trial: 특정 행동에 대한 동적 상상 1회
- Class: 특정 행동 (ex: 왼손, 오른손, 양발, 혀)
- EEG 데이터: $\mathbf{R}^{N\times T}$ (N: 채널 수, T: 전체 time point의 개수)
  - 채널: EEG 신호를 측정하는 전극
  - 측정된 연속된 EEG 신호는 sampling frequency에 따라서 discrete한 신호로 변환됨
  - Sampling frequency: 1초당 측정된 time point의 개수
- Session: 각 데이터가 찍힌 날짜



1 trial for motor imagery (BCI Competition IV-2a)



Electrode montage (BCI Competition IV-2a)

Dataset

- BCI Competition IV-2a dataset
- 9 subjects
- Classes: left hand, right hand, feet, tongue (4 classes)
- Session-to-session set up (=subject dependent)
- Training set: 216 trials per subject
- Validation set: 72 trials per subject
- Test set: 288 trials per subject

Preprocessing

- Sampling rate: 250Hz
- Time segment: [0.5, 2.5]s post-cue
- Band-pass: 0-38Hz
- Normalization: exponential moving average

04

Evaluation

Baseline accuracy

Model	Subject									Mean
	S01	S02	S03	S04	S05	S06	S07	S08	S09	
EEGNet	76.74	54.51	79.17	54.51	63.19	57.64	83.68	75.00	68.40	68.09

Hyper parameter

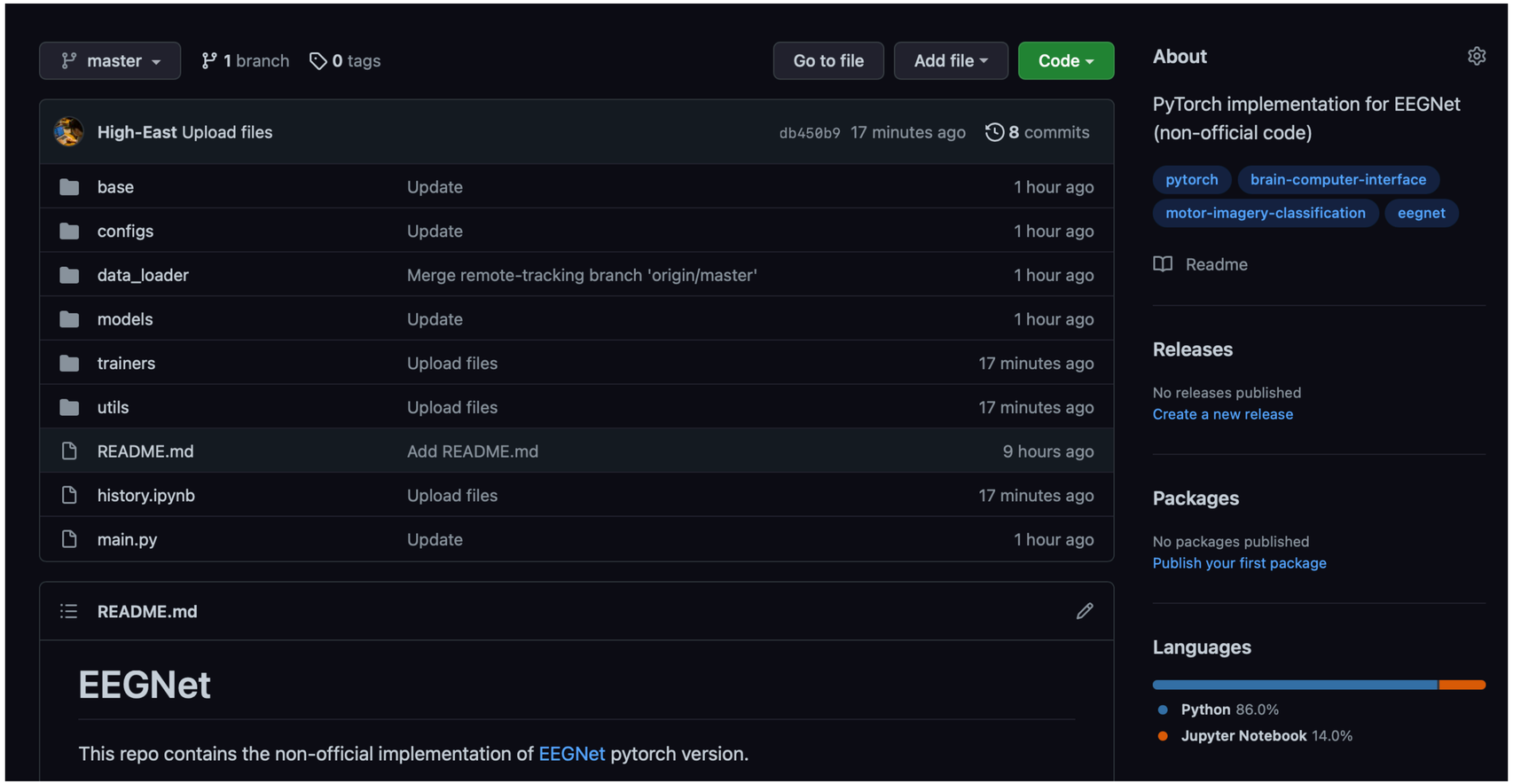
- Batch size: 72
- Epoch: 1000
- Optimizer: Adam
- Learning rate: 2e-03
- Weight decay: 2e-03
- Scheduler: cosine annealing

05

Baseline code

Github

- Pytorch == 1.9.0
- https://github.com/High-East/XAI606-EEGNet



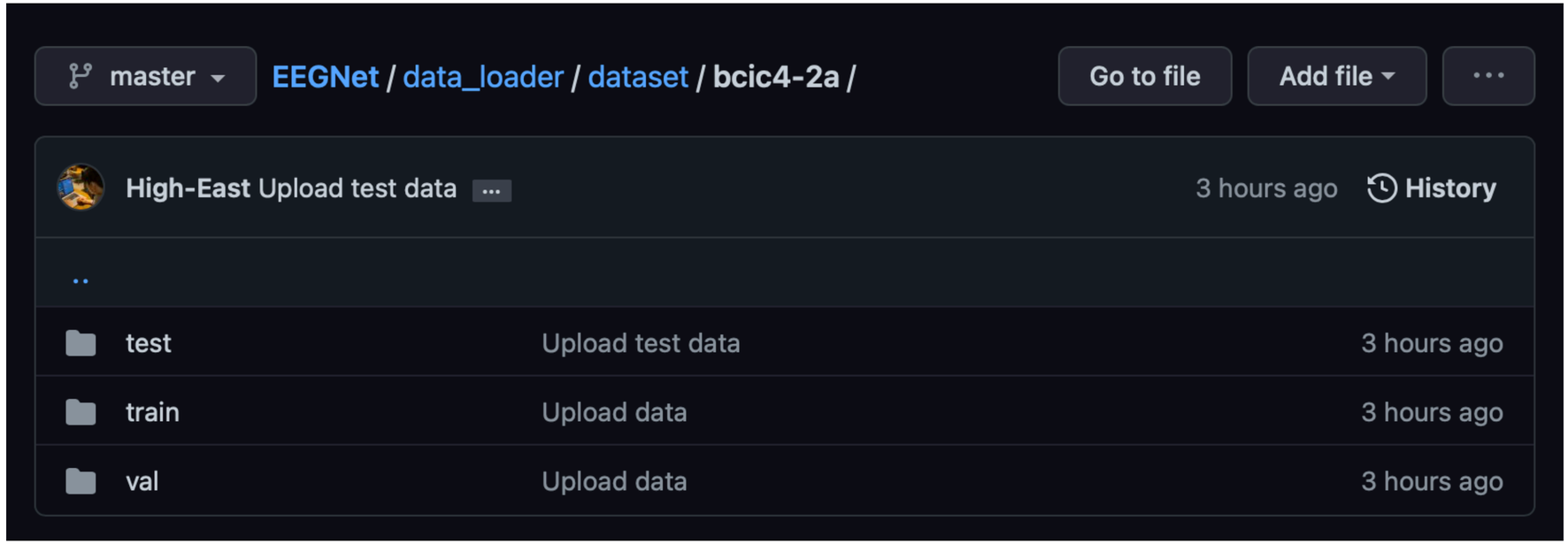
Baseline code

37 lines (27 sloc) | 838 Bytes

Raw Blame

```python
from utils.get_args import Args
from utils.utils import fix_random_seed, timeit
from data_loader.data_generator import DataGenerator
from models.model_builder import ModelBuilder
from trainers.trainer_maker import TrainerMaker


@timeit
def main():
    args_class = Args()
    args = args_class.args

    for args.subject in args.target_subject:
        args_class.preprocess()
        args_class.print_info()

        # Fix random seed
        if args.seed:
            fix_random_seed(args)

        # Load data
        data = DataGenerator(args)

        # Build model
        model = ModelBuilder(args).model

        # Make Trainer
        trainer = TrainerMaker(args, model, data).trainer

        if args.mode == 'train':
            trainer.train()
        else:
            trainer.test()


if __name__ == '__main__':
    main()
```

Dataset


master
EEGNet / data_loader / dataset / bcic4-2a /
Go to file
Add file
High-East Upload test data
3 hours ago
History
..
test
Upload test data
3 hours ago
train
Upload data
3 hours ago
val
Upload data
3 hours ago

06

Submission

Submission

- Submit prediction file.
- donghee-ko@korea.ac.kr

Thank you