Lab 5
Convolutional Neural Network

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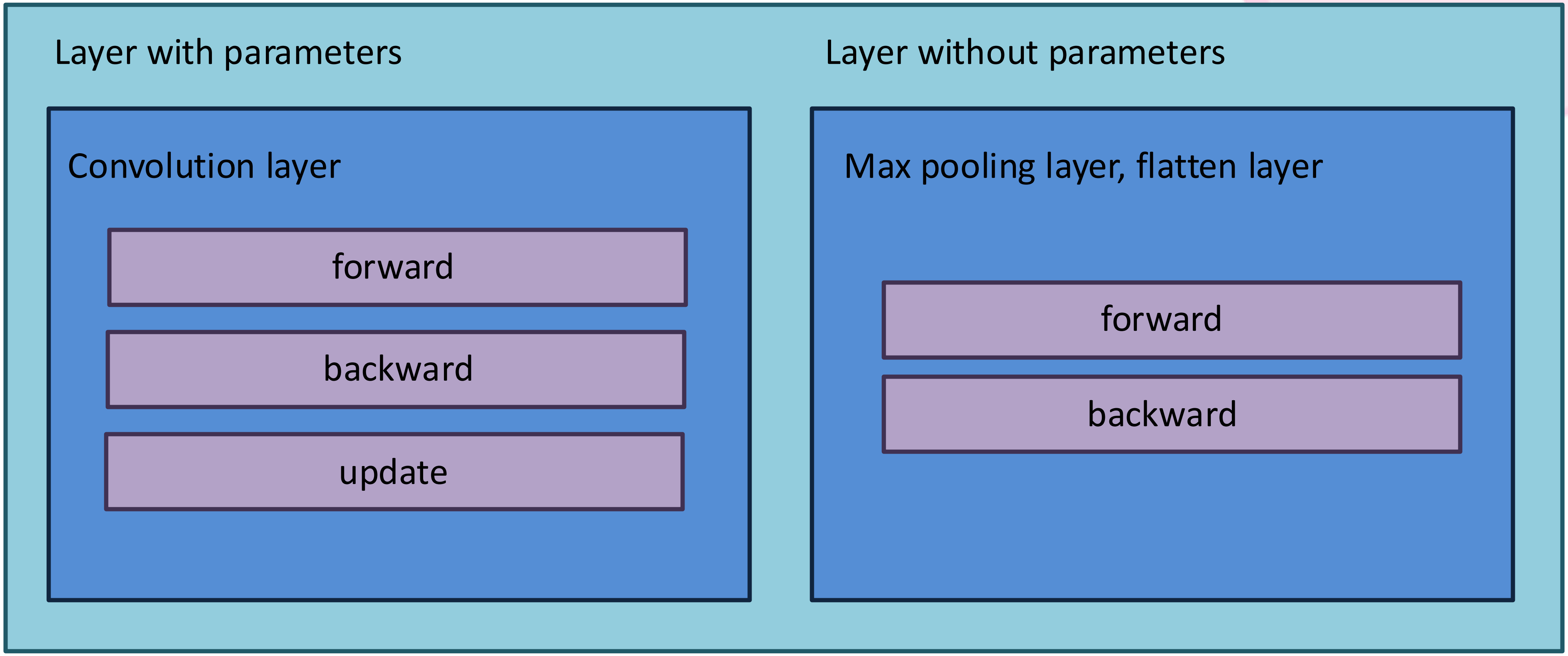
Goal

- Build your own convolutional neural network step by step.
- Extend your previous NN to **C**NN.
- Implement certain functions required to build a convolutional neural network.
- Understand how the convolution layer and max pooling layer work, including forward propagation, backward propagation and update.
- Build a convolutional neural network to predict the pulmonary disease of patients from their chest X-ray images.

Grading Policy

Item	Score
Basic Implementation	65%
Advanced Implementation	30%
Report	5%

Overview



Layer with parameters

Convolution layer

forward

backward

update

Layer without parameters

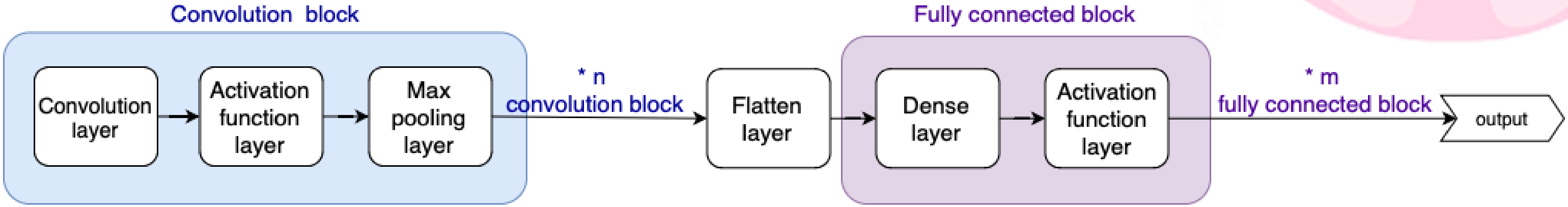
Max pooling layer, flatten layer

forward

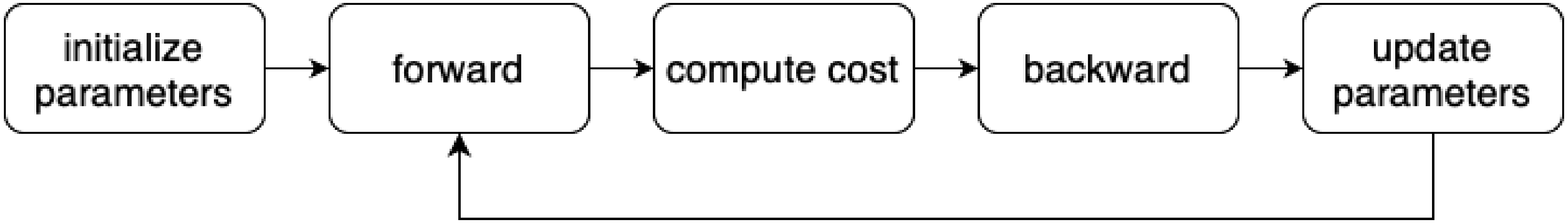
backward

Overview

CNN model structure (suggestion)



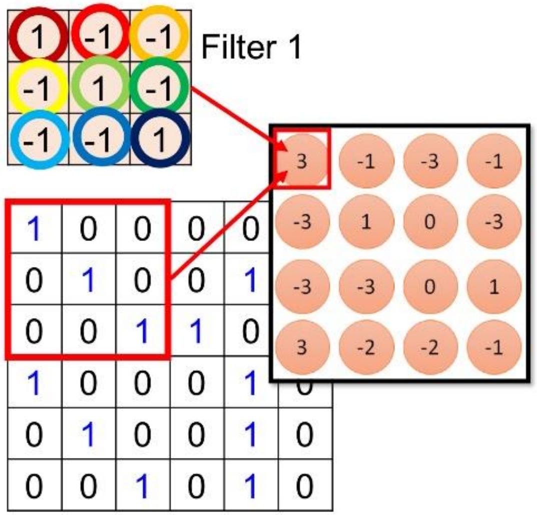
Training process



Basic Implementation (65%)

Convolution layer (30%)

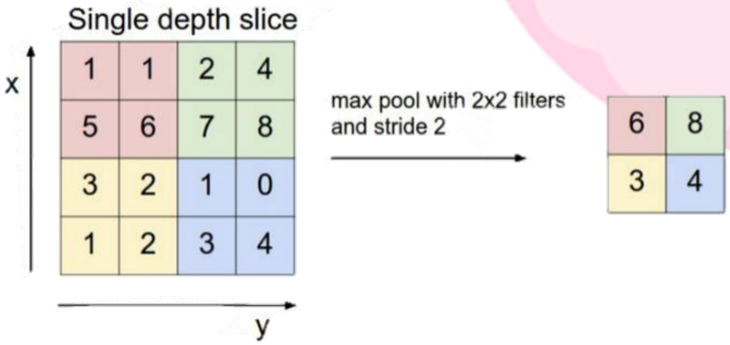
1. Implement zero_pad function (3%)
2. Implement convolution single step (5%)
3. Implement forward pass (10%)
4. Implement backward pass (10%)
5. Implement convolution update parameters (2%)



Basic Implementation (65%)

Max pooling layer (20%)

1. Implement forward pass (10%)
2. Implement backward pass (10%)

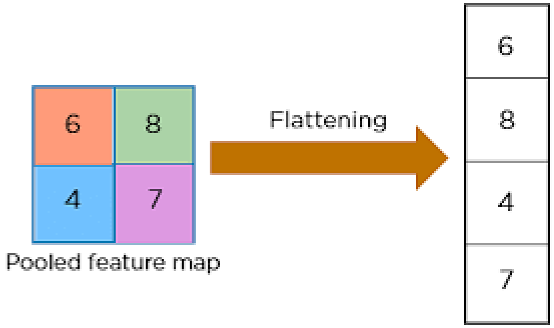


1	1	2	4
5	6	7	8
3	2	1	0
1	2	3	4

6	8
3	4

Flatten layer (10%)

1. Implement forward pass (5%)
2. Implement backward pass (5%)



6	8
4	7

6
8
4
7

Model (5%)

1. Implement forward pass, backward pass, update parameters (5%)

Advanced Implementation (30%)

Designing a CNN Model for Binary Classification

1. Implement a CNN binary classifier and try to get a good performance.
2. You can only use the functions you implement in the basic part.
3. We will use **accuracy** to evaluate your model.
    - Baseline: Accuracy > 0.65 (10%)
    - Baseline: Accuracy > 0.75 (10%)
    - Ranking (10%)

Data

Binary classification: Chest X-rays images

1. You will receive 600 samples as training data (300 normal and 300 abnormal), 300 samples as public testing data, and 300 samples as private testing data.
2. Use the training data to predict whether the patient in test data is normal or not.
3. 0: normal / 1: abnormal
4. The shape of X_train is (600, 32, 32, 1) and the value of each pixel is between 0 and 1.

Lab5_output.npy File Format

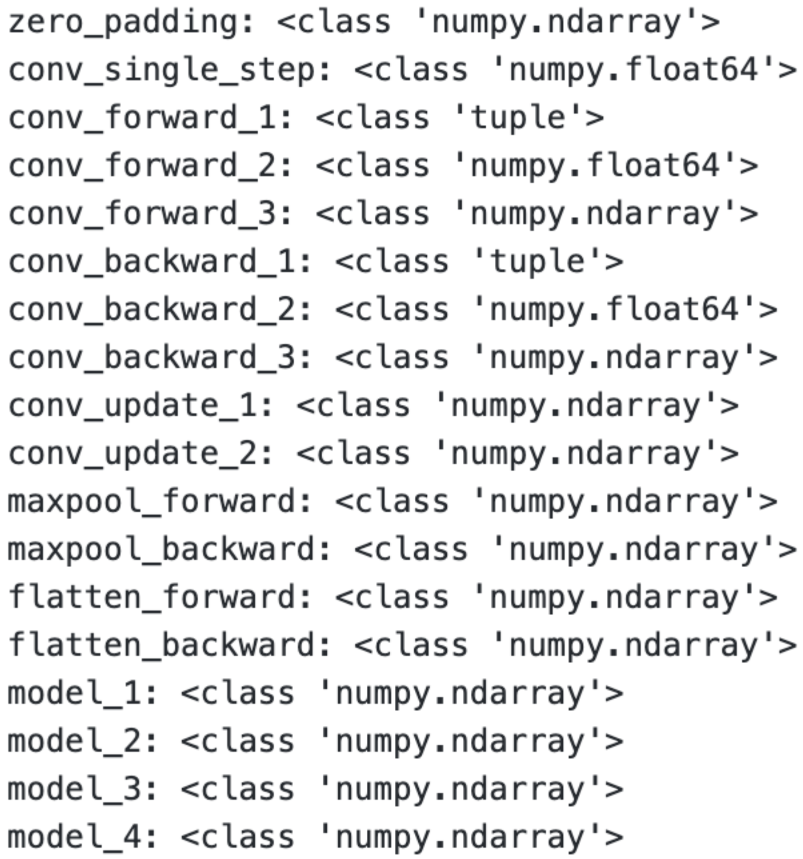
- Named as “**Lab5_output.npy**”
- This file is a dictionary that stores the output for each function. You can use the provided sanity check in the notebook to ensure nothing is missing. The dictionary should include the following 18 keys:

  - ✓ 'zero_padding’,
  - ✓ 'conv_single_step’,
  - ✓ 'conv_forward_1’,
  - ✓ 'conv_forward_2’,
  - ✓ 'conv_forward_3’,
  - ✓ 'conv_backward_1’,
  - ✓ 'conv_backward_2’,
  - ✓ 'conv_backward_3’,
  - ✓ 'conv_update_1’,
  - ✓ 'conv_update_2’,
  - ✓ 'maxpool_forward’,
  - ✓ 'maxpool_backward’,
  - ✓ 'flatten_forward’,
  - ✓ 'flatten_backward’,
  - ✓ 'model_1’,
  - ✓ 'model_2’,
  - ✓ 'model_3’,
  - ✓ 'model_4’

Lab5_output.npy File Format

- We will test your ”**Lab5_output.npy**” to verify the correctness of your basic implementation.

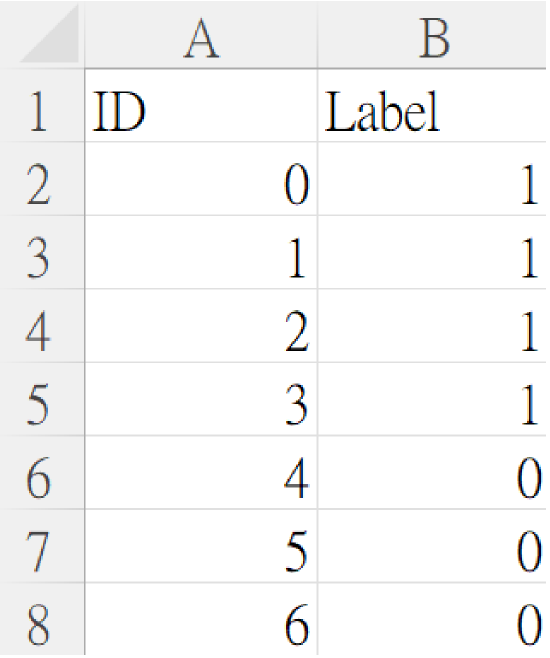
- Submit this file to eeclass.



```
zero_padding: <class 'numpy.ndarray'>
conv_single_step: <class 'numpy.float64'>
conv_forward_1: <class 'tuple'>
conv_forward_2: <class 'numpy.float64'>
conv_forward_3: <class 'numpy.ndarray'>
conv_backward_1: <class 'tuple'>
conv_backward_2: <class 'numpy.float64'>
conv_backward_3: <class 'numpy.ndarray'>
conv_update_1: <class 'numpy.ndarray'>
conv_update_2: <class 'numpy.ndarray'>
maxpool_forward: <class 'numpy.ndarray'>
maxpool_backward: <class 'numpy.ndarray'>
flatten_forward: <class 'numpy.ndarray'>
flatten_backward: <class 'numpy.ndarray'>
model_1: <class 'numpy.ndarray'>
model_2: <class 'numpy.ndarray'>
model_3: <class 'numpy.ndarray'>
model_4: <class 'numpy.ndarray'>
```

Lab5_prediction.csv file format

- There should be (600+1) rows in your csv file
  - First row is the header [ID, Label]
  - Your prediction answer should be either 0 or 1
  - **ID** starts from 0, and **Label** is the predicted answer
- Please make sure that your output format is correct
- Submit the answer (Lab5_prediction.csv) to Kaggle



	A	B
1	ID	Label
2	0	1
3	1	1
4	2	1
5	3	1
6	4	0
7	5	0
8	6	0

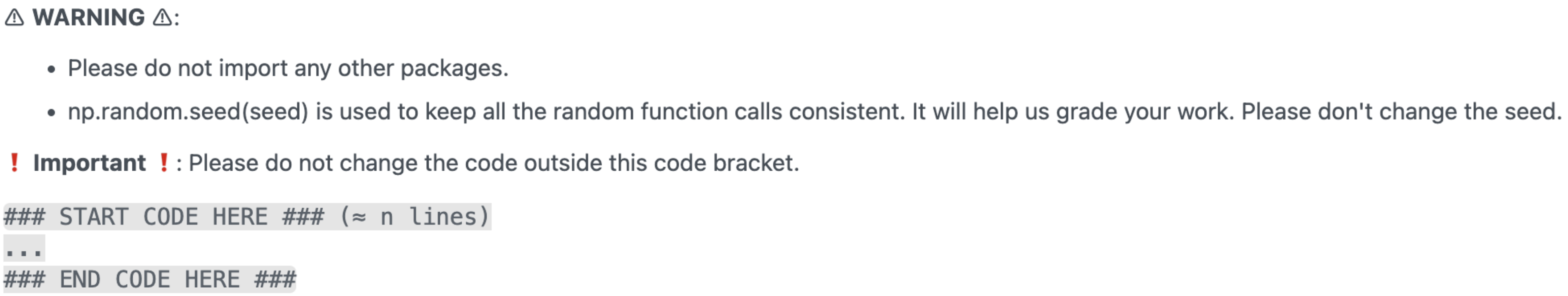
Items for you

- Template: **Lab5_template.ipynb**
- Some files: **Dense.py, Activation.py, Loss.py** (You can paste the code you wrote in Lab4 into these files). Additionally, a helper function file, **Predict.py**, is provided to assist with model predictions **(you don't need to modify this file)**.
- Data(including training and testing data): **data.npz**
- Sample submission csv file: **Sample_submission.csv**

Template

Except for the imported packages in the template, you cannot use any other packages (ex: tqdm).

Remember to save the code file to **Lab5.ipynb** and submit it to eeclass.



⚠ **WARNING** ⚠:

- Please do not import any other packages.
- np.random.seed(seed) is used to keep all the random function calls consistent. It will help us grade your work. Please don't change the seed.

❗ **Important** ❗: Please do not change the code outside this code bracket.

```
### START CODE HERE ### (≈ n lines)
...
### END CODE HERE ###
```

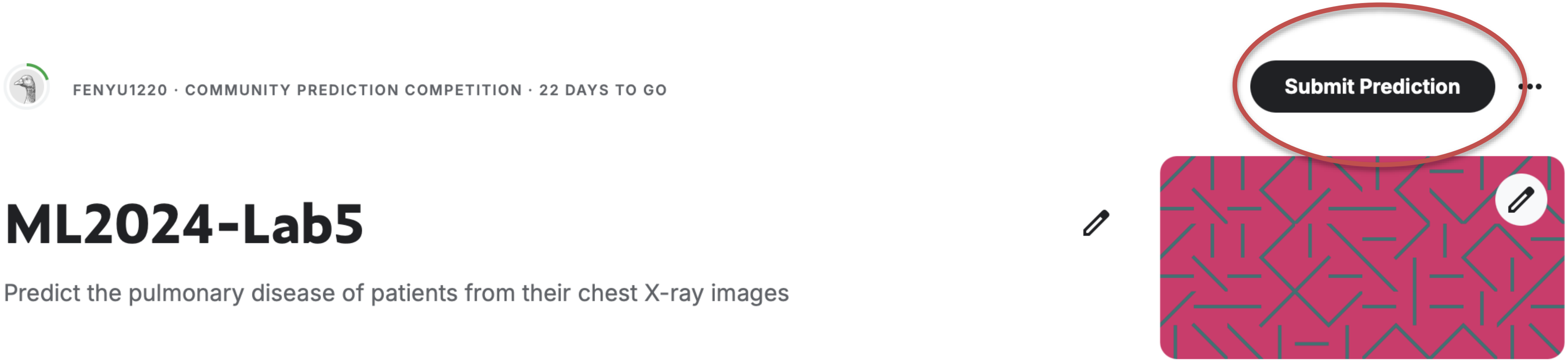
Kaggle

We’ve created competitions for the advanced part.

- Kaggle link: https://www.kaggle.com/t/3c1c6515bc5941b1a9bf6cda1642827c
- The testing set is divided, with 50% designated as public and the remaining 50% as private.
- Only the public score will be visible on Kaggle.
- All final scores will be based on the private score.

Kaggle

- Please register your account.
- Click the ‘Join competition’ button to join.



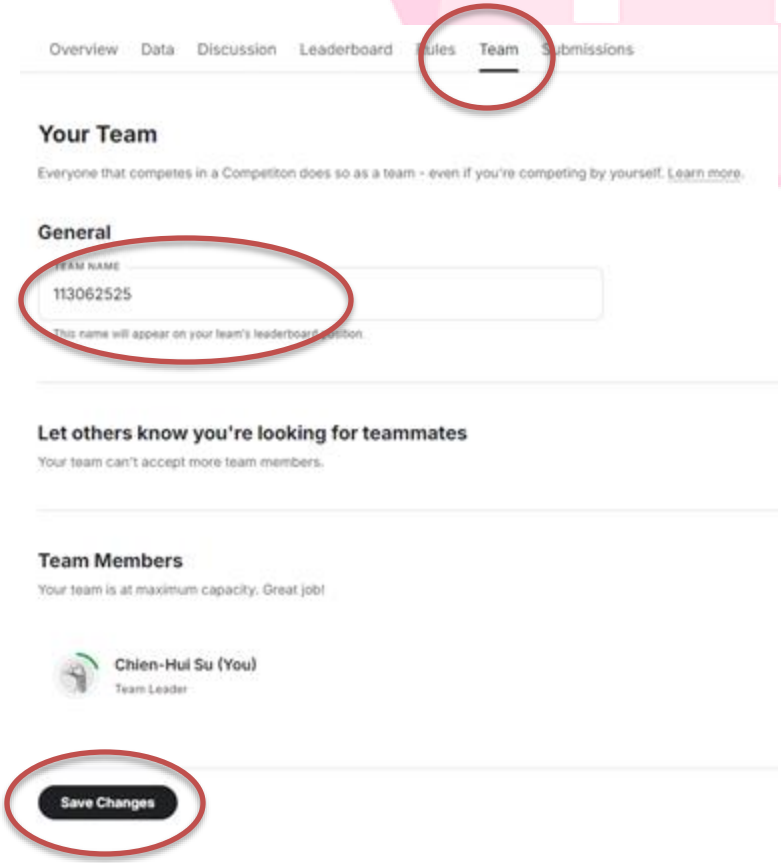
FENYU1220 · COMMUNITY PREDICTION COMPETITION · 22 DAYS TO GO

ML2024-Lab5

Predict the pulmonary disease of patients from their chest X-ray images

Kaggle

- After joining the competition, you should change your team's name (each student is a team) to your **student ID**.
- **Please remember to SAVE CHANGES**
- You can submit 50 times per day.



Your Team

Everyone that competes in a Competiton does so as a team - even if you're competing by yourself. Learn more.

General

TEAM NAME: 113062525

This name will appear on your team's leaderboard position.

Let others know you're looking for teammates

Your team can't accept more team members.

Team Members

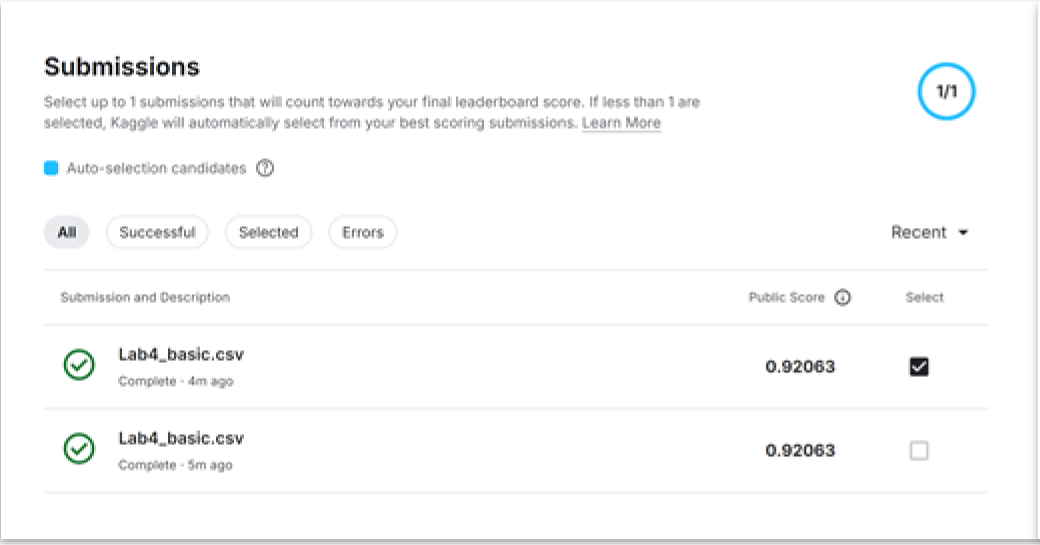
Your team is at maximum capacity. Great job!

Chien-Hui Su (You)
Team Leader

Notes: Please verify your team's name on the leaderboard - changing profile name does not change team name.

Kaggle

You can manually select up to 1 submission that will count towards your final leaderboard score. If no submission is selected, Kaggle will automatically select your submission with the best public score.



Submissions

Select up to 1 submissions that will count towards your final leaderboard score. If less than 1 are selected, Kaggle will automatically select from your best scoring submissions. Learn More

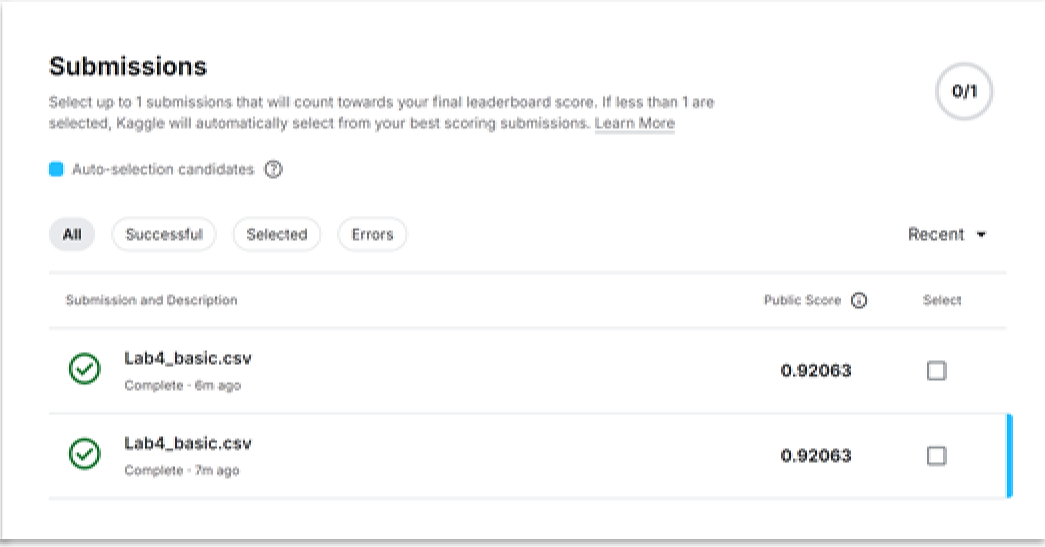
1/1

■ Auto-selection candidates ⓘ

All · Successful · Selected · Errors · Recent ▾

Submission and Description	Public Score ⓘ	Select
✓ Lab4_basic.csv Complete · 4m ago	0.92063	☑
✓ Lab4_basic.csv Complete · 5m ago	0.92063	□

Manual-selection



Submissions

Select up to 1 submissions that will count towards your final leaderboard score. If less than 1 are selected, Kaggle will automatically select from your best scoring submissions. Learn More

0/1

■ Auto-selection candidates ⓘ

All · Successful · Selected · Errors · Recent ▾

Submission and Description	Public Score ⓘ	Select
✓ Lab4_basic.csv Complete · 6m ago	0.92063	□
✓ Lab4_basic.csv Complete · 7m ago	0.92063	□

Auto-selection

Report

1. Explain why ReLU is typically preferred over Sigmoid as the activation function in the convolutional block? (1%)
2. Describe how you design the CNN architecture and your findings in choosing parameters such as `filter_size` and `pool_size` for each layer? (2%)
3. Calculate and compare the number of learnable parameters between the CNN model and the NN model you designed for binary classification in Lab4. For simplicity, omit the bias parameters and calculate only the weights. (2%)

Notes:

1. Do not exceed 2 pages!
2. Name your report file as “**Lab5_report.pdf**”.

Requirement

- Do it individually! Not as a team! (team is for final project)
- Announce date: 2024/11/12
- Deadline: 2024/11/26 23:59 (Late submission is not allowed!)
- Submit the answers (Lab5_prediction.csv) to the Kaggle competition (Ensure that your leaderboard **team name** matches your **student ID**)
  - Advanced: https://www.kaggle.com/t/3c1c6515bc5941b1a9bf6cda1642827c
- Hand in your files in the following format (Do not zip the files!)
  - Lab5.ipynb (Please keep your execution output)
  - Lab5_output.npy
  - Lab5_report.pdf
- Lab 5 will be covered on the next exam.

Penalty

0 points if any of the following conditions happened:

- Plagiarism
- Late submission
- Not using a template or importing any other packages
- Incorrect input/output format
- No submission record on Kaggle
- Wrong team name on Kaggle (the team name is not your student id)
- No code("**Lab5.ipynb**") submission on eeclass
- Your submission was not generated by your code

5 Points would be deducted if your submission format is incorrect

0 Points will be given in the Basic implementation if you don't submit "**Lab5_output.npy**"

Questions?

- TA:
  - Pin-Shun Wang (wangpinshun@gmail.com)
  - Fen-Yu Hsieh (fenyu9867@gmail.com)
- **No debugging service**