Machine Learning HW4
Speaker Identification

ML TAs
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Outline

- Task Description
- Dataset
- Data Segmentation
- Model Architecture
- Baselines
- Report
- Guidelines

Task Introduction

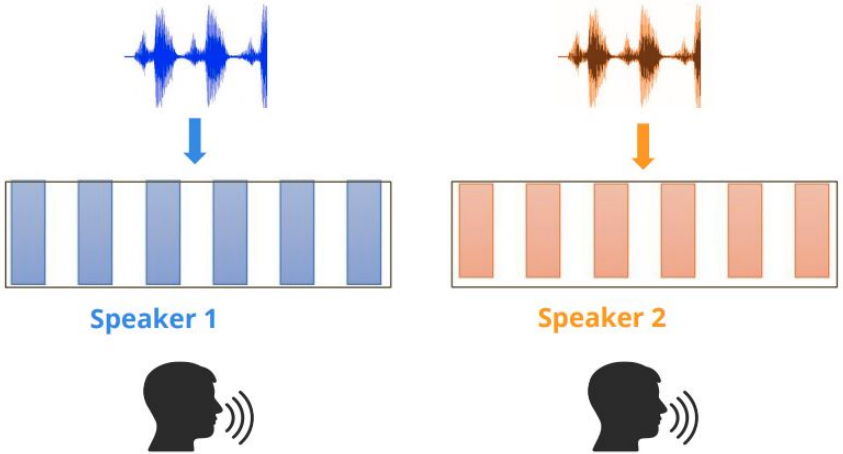
- Self-attention
  - Proposed in GOOGLE's work, Attention is all you need. It combines the strengths of RNN (consider the whole sequence) and CNN (processing parallelly).
- Goal: Learn how to use Transformer.

Ref. Prof. Hung-Yi Lee
[2021Spring ML] Transformer (1), (2)

Speaker Identification

Task: Multiclass Classification

Predict speaker class from given speech.

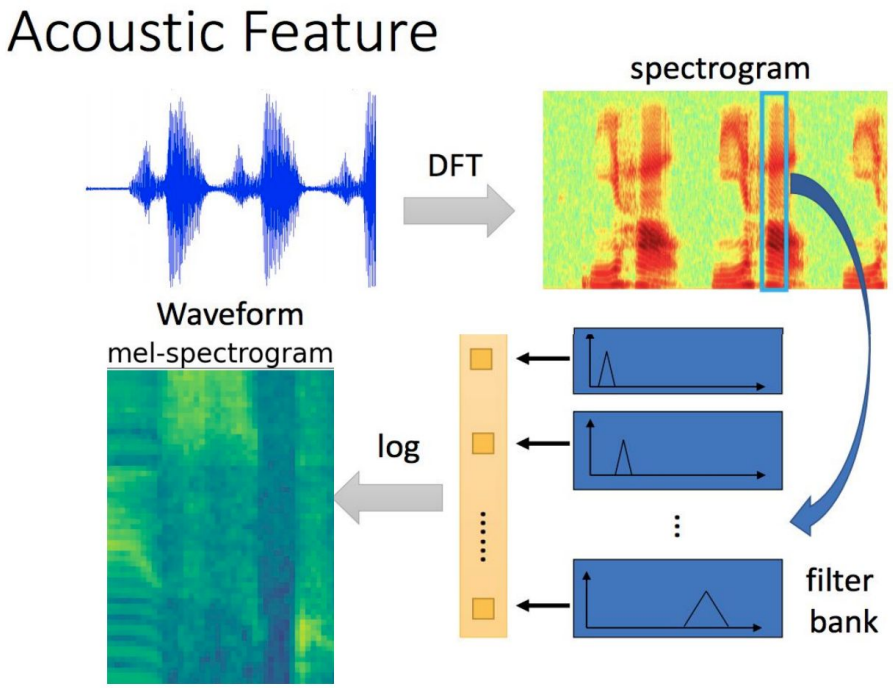


Dataset - VoxCeleb2

- Training: 56666 processed audio features with labels.
- Testing: 4000 processed audio features (public & private) without labels.
- Label: 600 classes in total, each class represents a speaker.

VoxCeleb2: Link

Data Preprocessing



Ref. Prof. Hung-Yi Lee
[2020Spring DLHLP] Speech Recognition

Data Format

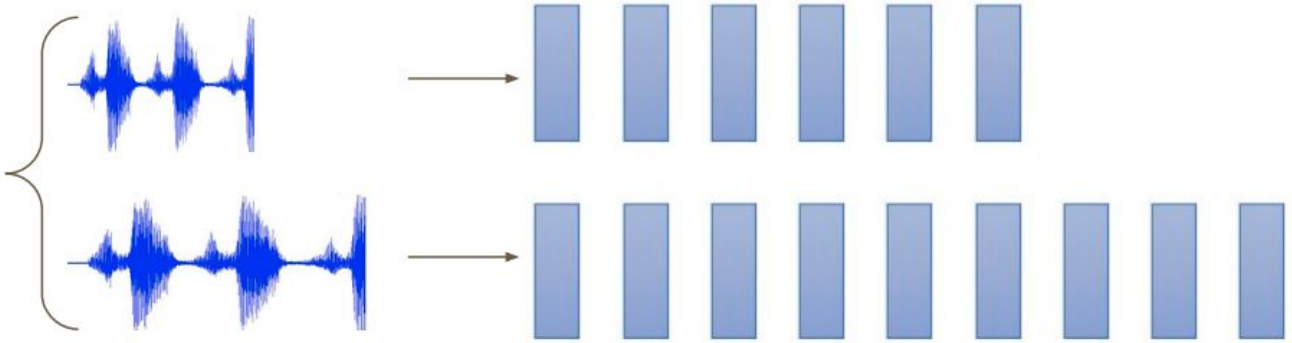
- Data Directory
  - metadata.json
  - testdata.json
  - mapping.json
  - uttr-{random string}.pt
- The information in metadata
  - "n_mels": The dimention of mel-spectrogram.
  - "speakers": A dictionary.
    - Key: speaker ids
    - Value: "feature_path" and "mel_len"

```
mapping.json
metadata.json
sox_effects.pt
testdata.json
uttr-0002067f80214182ab863378bdcdd68a.pt
uttr-00020e01ed0549928fb3dc8fa50e9cbb.pt
uttr-00031f1879ae44dea75db5aa4ed72b87.pt
uttr-0003464b61764fe98d7992fac6cb66dd.pt
```


```
{
    "n_mels": 40,
    "speakers": {
        "id03074": [
            {
                "feature_path": "uttr-18e375195dc146fd8d14b8a322c29b90.pt",
                "mel_len": 435
            },
            {
                "feature_path": "uttr-da9917d5853049178487c065c9e8b718.pt",
                "mel_len": 490
            },
```

Data Segmentation During Training

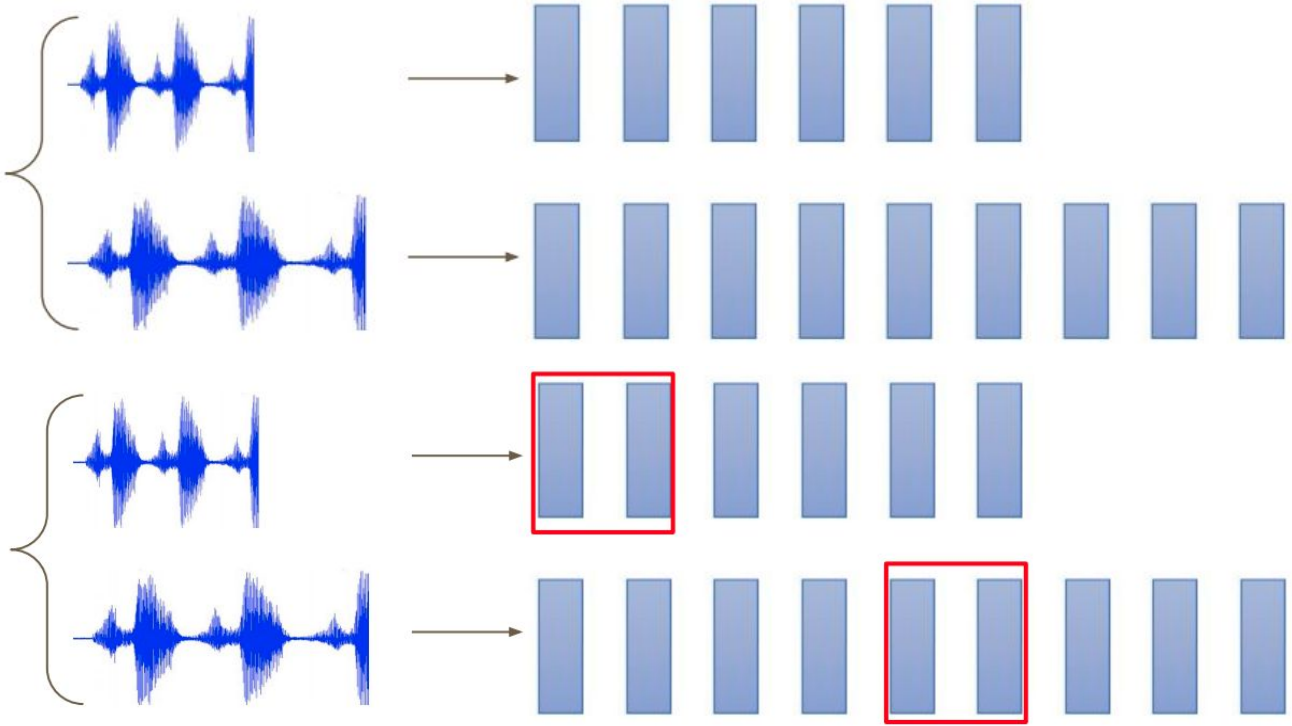
Different length:



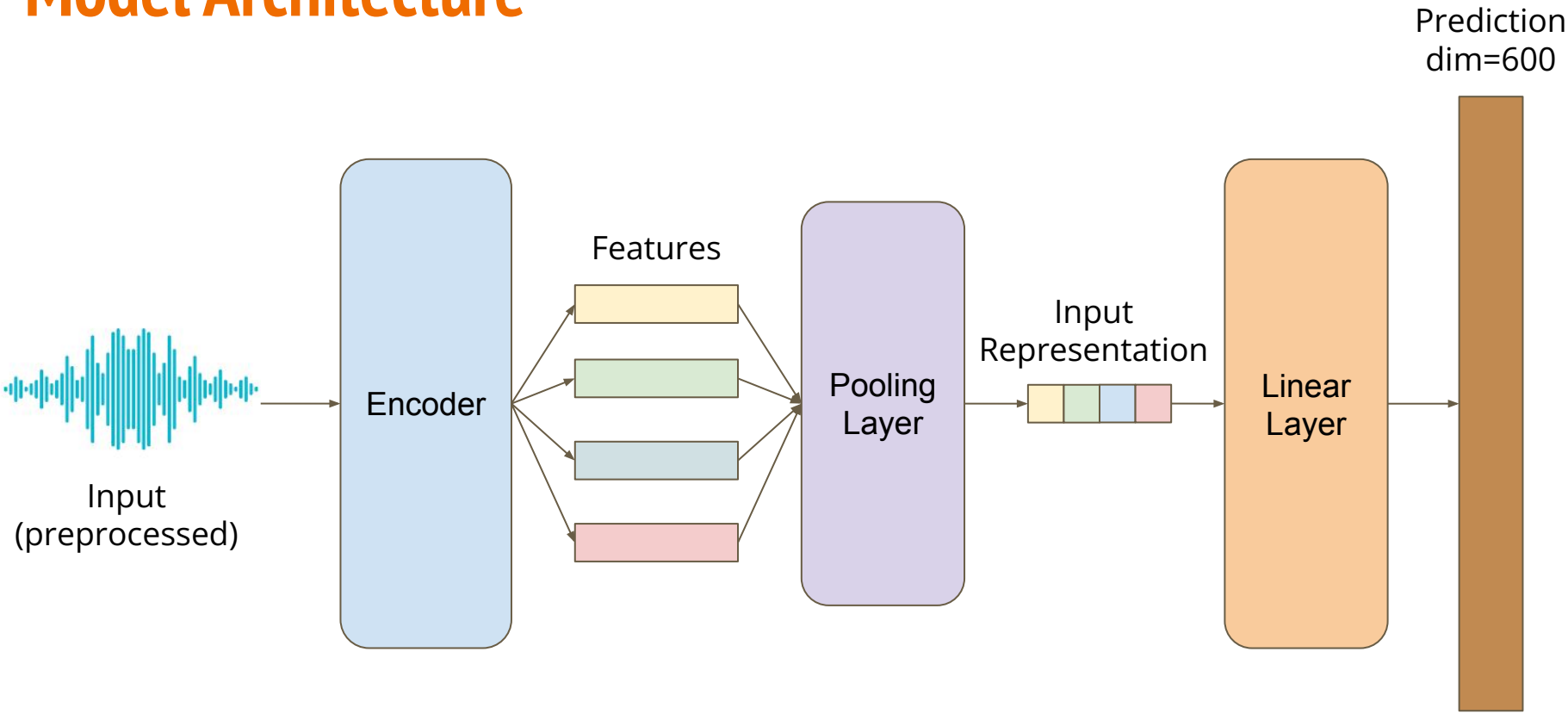
Data Segmentation During Training

Different length:

Segment during training
Segment = 2



Model Architecture



Sample Code

- Link
- Baseline Methods
  - Simple: Run sample code & know how to use Transformer.
  - Medium: Know how to adjust parameters of Transformer.
  - Strong: Construct Conformer, which is a variety of Transformer.
  - Boss: Implement Self-Attention Pooling & Additive Margin Softmax to further boost the performance.

Requirements - Simple

- Build a self-attention network to classify speakers with sample code.
- Simple public baseline: 0.60824
- Estimate training time: 30~40 mins on Colab.

Requirements - Medium

- Modify the parameters of the transformer modules in the sample code.
- Medium public baseline: 0.70375

```
class Classifier(nn.Module):
  def __init__(self, d_model=80, n_spks=600, dropout=0.1):
    super().__init__()
    # Project the dimension of features from that of input into d_model.
    self.prenet = nn.Linear(40, d_model)
    # TODO:
    #   Change Transformer to Conformer.
    #   https://arxiv.org/abs/2005.08100
    self.encoder_layer = nn.TransformerEncoderLayer(
      d_model=d_model, dim_feedforward=256, nhead=2
    )
    # self.encoder = nn.TransformerEncoder(self.encoder_layer, num_layers=2)

    # Project the the dimension of features from d_model into speaker nums.
    self.pred_layer = nn.Sequential(
      nn.Linear(d_model, d_model),
      nn.ReLU(),
      nn.Linear(d_model, n_spks),
    )
```

Estimate training time:
1~1.5 hour on Colab

Requirements - Strong

- Construct Conformer, which is a variety of Transformer.
- Strong public baseline: 0.77750

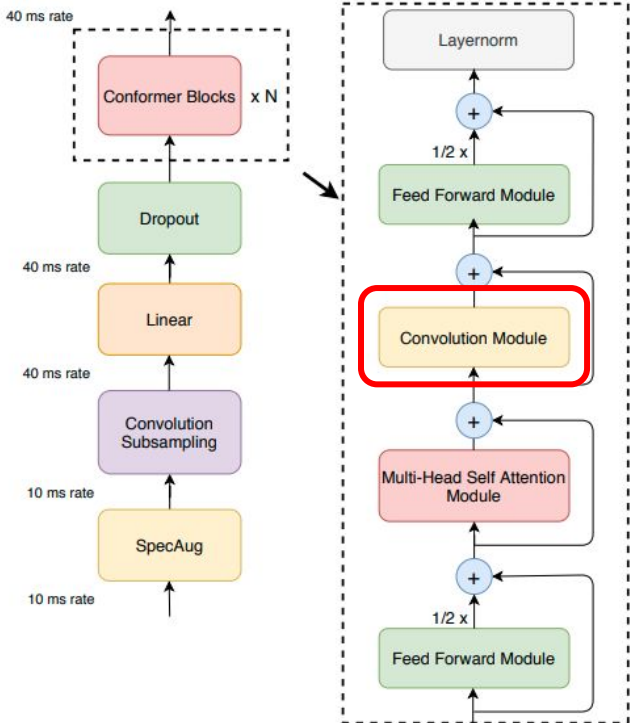
```
class Classifier(nn.Module):
  def __init__(self, d_model=80, n_spks=600, dropout=0.1):
    super().__init__()
    # Project the dimension of features from that of input into d_model.
    self.prenet = nn.Linear(40, d_model)
    # TODO:
    #   Change Transformer to Conformer.
    #   https://arxiv.org/abs/2005.08100
    self.encoder_layer = nn.TransformerEncoderLayer(
      d_model=d_model, dim_feedforward=256, nhead=2
    )
    # self.encoder = nn.TransformerEncoder(self.encoder_layer, num_layers=2)

    # Project the the dimension of features from d_model into speaker nums.
    self.pred_layer = nn.Sequential(
      nn.Linear(d_model, d_model),
      nn.ReLU(),
      nn.Linear(d_model, n_spks),
    )
```

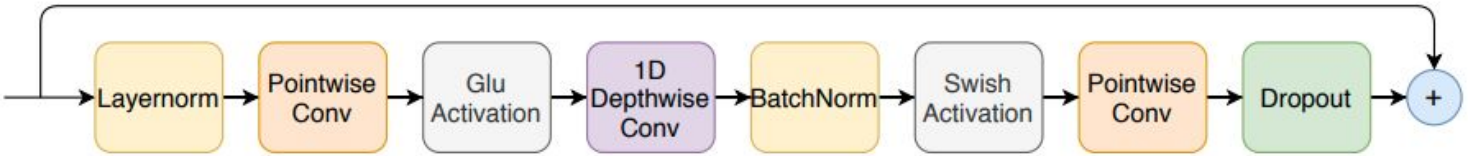
Estimate training time:
3 ~4 hours on Colab

Hints

- Conformer



Ref. Prof. Hung-Yi Lee [2021Spring ML] Network Compression

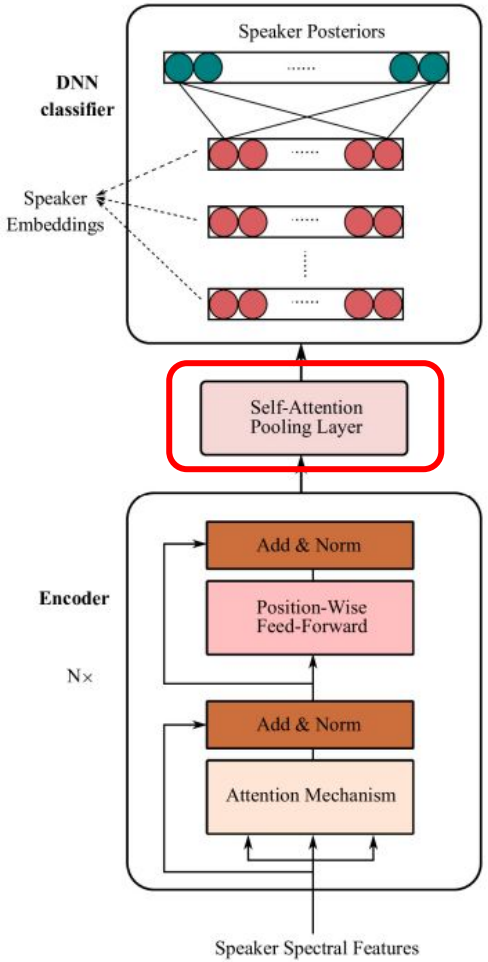


Requirements - Boss

- Implement Self-Attention Pooling & Additive Margin Softmax to further boost the performance.
- Public boss baseline: 0.86500
- Estimate training time: about 2~2.5 hours on Kaggle.

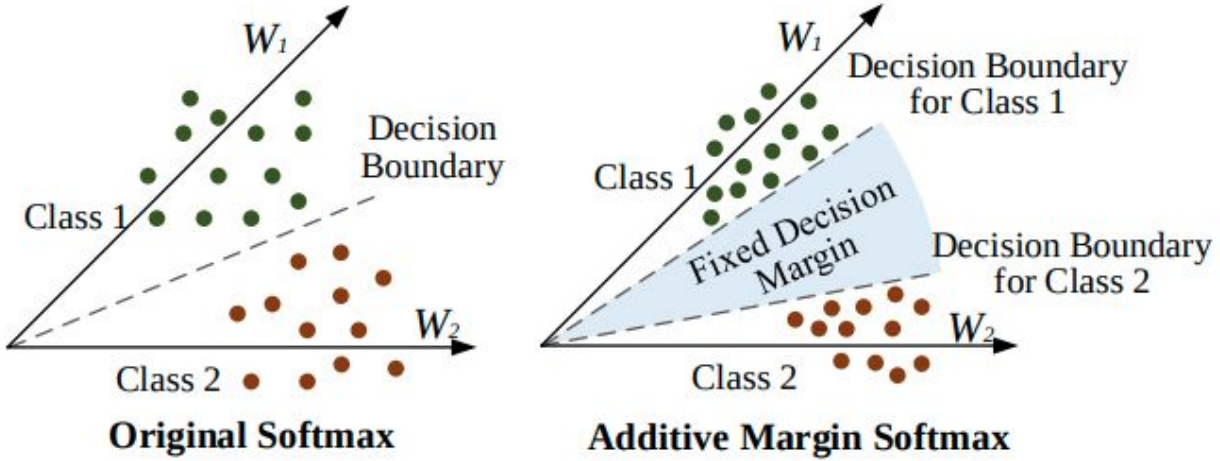
Hints

- Self-Attention Pooling



Hints

- Additive Margin Softmax



Grading

- Evalute Metric: @1 Accuracy
- Simple Baseline (Public / Private) +0.5 pt / 0.5 pt
- Medium Baseline (Public / Private) +0.5 pt / 0.5 pt
- Strong Baseline (Public / Private) +0.5 pt / 0.5 pt
- Boss Baseline (Public / Private) +0.5 pt / 0.5 pt
- Code Submission +2 pts
- Report +4 pts

Submission Format

- "Id, Category" split by ',' in the first row.
- Followed by 8000 lines of "filename, speaker name" split by ','.

```
Id,Category
uttr-434259d99e6a4a34b9a4bf75c9487229.pt,id00000
uttr-81afc99b0d4c4411ba61ec19c1d6cf40.pt,id00000
uttr-600d499177b14f669f90ceca4491d817.pt,id00000
```

Code Submission

- Submit your code to **NTU COOL** (2 pts).
  - We can only see your **last submission**.
  - Do **NOT** submit the model or dataset.
  - If your codes are not reasonable, your final grade will be **x 0.9**
  - You should compress your code into a single zip file:
    - ex. b08902126_hw4.zip

<Student ID>_hw4.zip

Report (4 pts)

1. Make a brief introduction about a variant of Transformer. (2 pts)

2. Briefly explain why adding convolutional layers to Transformer can boost performance. (2 pts)

Deadline

- Kaggle: **2022/04/01 23:59 (UTC+8)**
- NTU COOL: **2022/04/01 23:59 (UTC+8)**
- Report: **2022/04/01 23:59 (UTC+8)**

Links

- Kaggle: link
- Colab: link
- Data: link
- Dataset: link

Regulation

- You should NOT plagiarize, if you use any other resource, you should cite it in the reference. (*)
- You should NOT modify your prediction files manually.
- Do NOT share codes or prediction files with any living creatures.
- Do NOT use any approaches to submit your results more than 5 times a day.
- **Do NOT search or use additional data or pre-trained models.**
- Your **final grade x 0.9** if you violate any of the above rules.
- Prof. Lee & TAs preserve the rights to change the rules & grades.

(*) Academic Ethics Guidelines for Researchers by the Ministry of Science and Technology (MOST)

If any questions, you can ask us via...

- NTU COOL (Recommended)
  - https://cool.ntu.edu.tw/courses/11666
- Email
  - mlta-2022-spring@googlegroups.com
  - The title should begin with “[hw4]”
- TA hour
  - Mandairn: Tuesday, 20:00~21:00
  - English: Friday, 22:00 ~ 23:00

Appendix

- Colab 縮排問題
  - 工具 -> 設定: