Digital Speech Processing Homework #3

ZhuYin Decoding

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November 24, 2021

Due on 23:59, December 17, 2021

Outline

1. Introduction
2. SRILM Toolkit
3. Homework
4. Requirements
5. Grading
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Introduction

ZhuYin Decoding 1/2

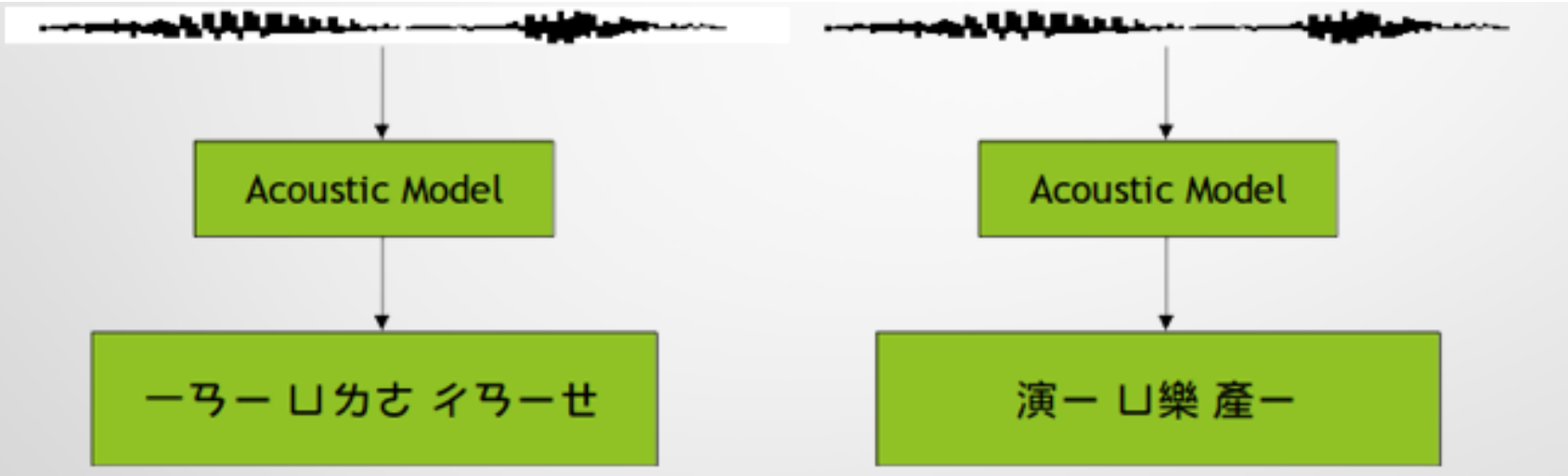
ZhuYin is used widely in our daily life.

- ㄔ完飯要ㄏ珍奶買ㄐ排冂？ → 吃完飯要喝珍奶買雞排嗎？
- 我覺ㄌ助教真ㄌ很嚴格 → 我覺得助教真的很嚴格
- 老尸我先走ㄌ，ㄅㄅ → 老師我先走了，掰掰
- 匚ㄓ是ㄎ以都ㄅ喝水ㄌ → 肥宅是可以都不喝水的

(Some sentences are combination of real examples.)

ZhuYin Decoding 2/2

In speech recognition, imperfect acoustic models with phoneme loss yield similar result, which we have to correct by post-processing.



→「演藝娛樂產業」

Language Model

Sentences can be reconstructed with the help of **language model**.

$$W^* = \underset{W}{\operatorname{argmax}}\ \mathrm{P}(W \mid Z) \tag{1}$$

$$= \underset{W}{\operatorname{argmax}}\ \frac{\mathrm{P}(W)\,\mathrm{P}(Z \mid W)}{\mathrm{P}(Z)} \tag{2}$$

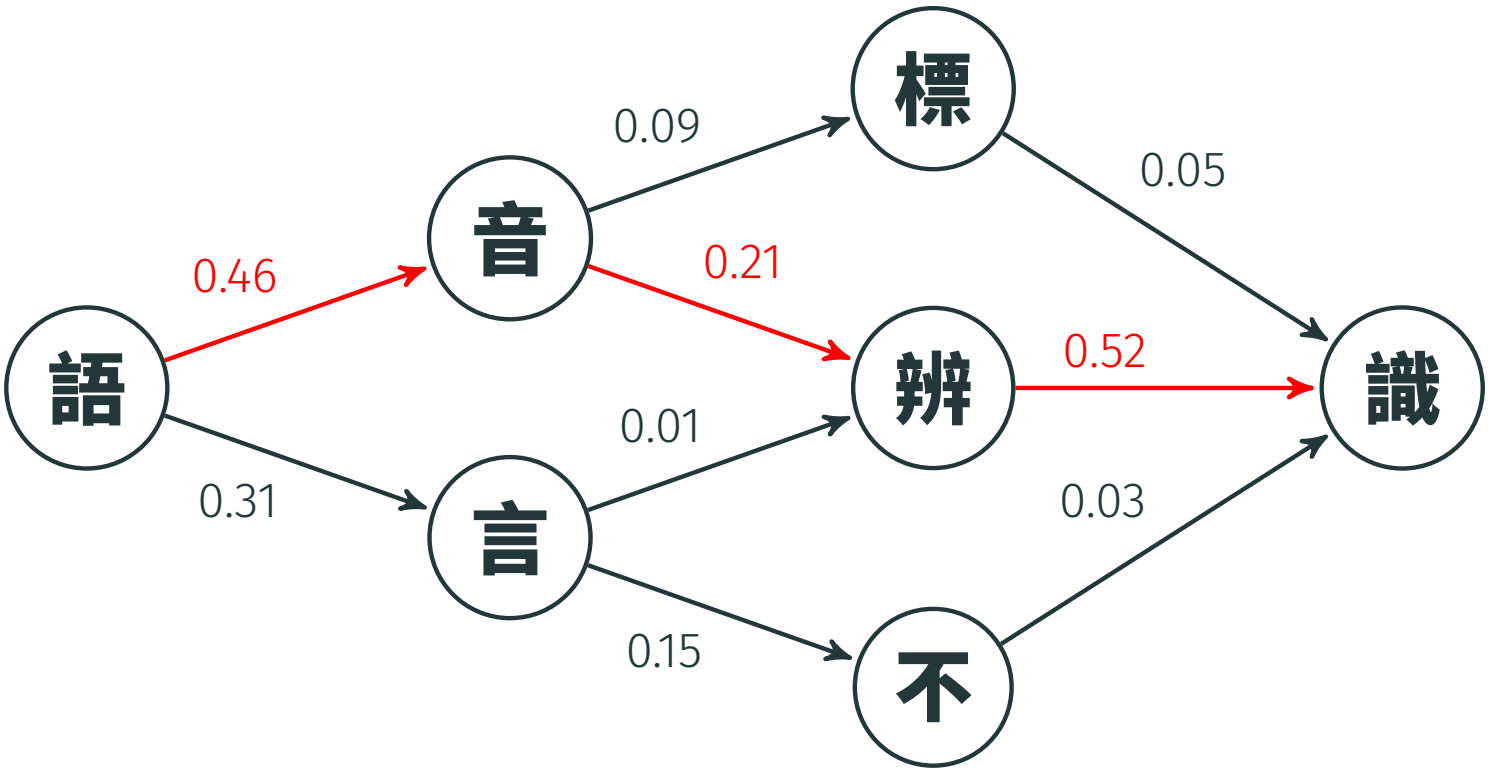
$$= \underset{W}{\operatorname{argmax}}\ \mathrm{P}(W)\,\mathrm{P}(Z \mid W) \tag{3}$$

$$= \underset{W}{\operatorname{argmax}}\ [\mathrm{P}(w_1)\prod_{i=2}^{n}\mathrm{P}(w_i \mid w_{i-1})][\prod_{i=1}^{n}\mathrm{P}(z_i \mid w_i)] \tag{4}$$

$$= \underset{W,\ \mathrm{P}(Z|W)\neq 0}{\operatorname{argmax}}\ [\mathrm{P}(w_1)\prod_{i=2}^{n}\mathrm{P}(w_i \mid w_{i-1})] \tag{5}$$

Viterbi Algorithm

Viterbi algorithm gives the path with the greatest probability.
For example, 語ー勹識



SRILM Toolkit

SRILM Toolkit

- SRILM Toolkit stands for SRI Language Modeling Toolkit.
- It is a toolkit for building and applying various statistical language models.
- It provides useful C++ libraries, which we are going to exploit in this homework.
- You can either download the pre-built docker image or compile from the source code on your own

Setup SRILM

We provide a pre-built docker image and strongly recommend you to complete hw3 in this environment. You can also compile from the source code. If so, please confirm your code can be run in our environment.
(Ubuntu 18.04, GCC version 7.4.0)

For pre-built docker image, simply use the following command[1]:

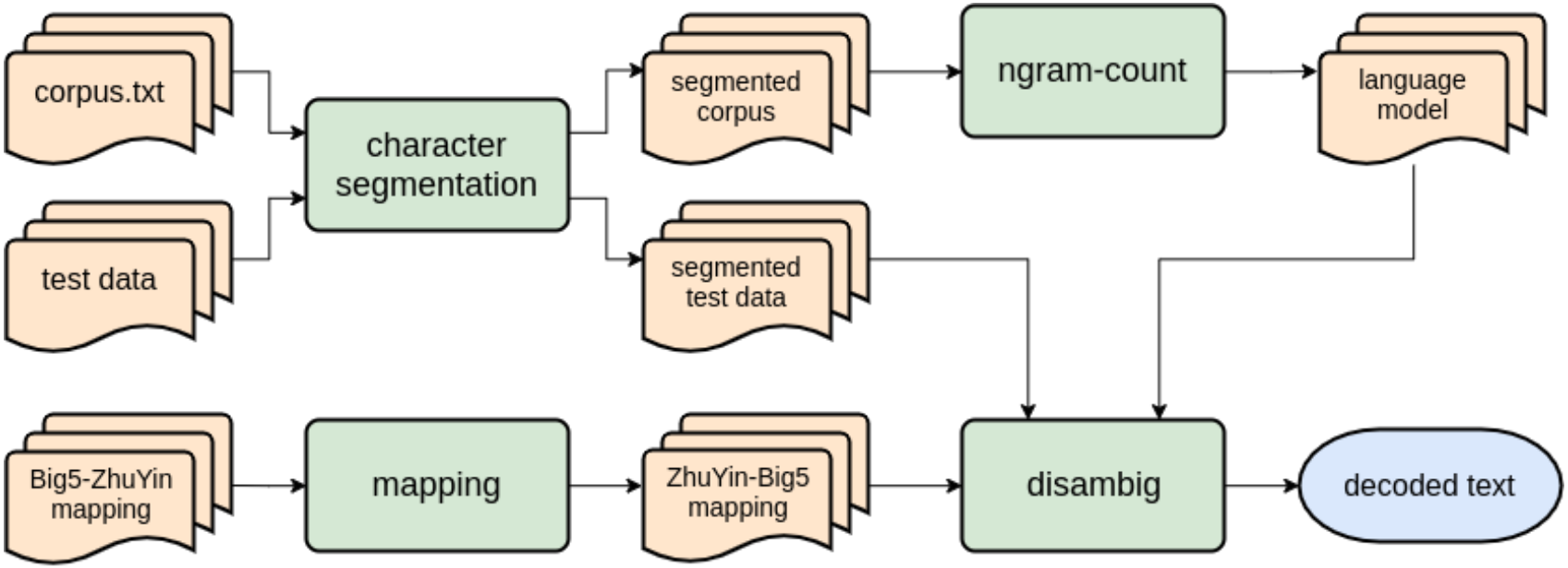
```
docker run -it ntudsp2020autumn/srilm
```

Please refer to FAQ[2] for more information.

[1] `-v` for mounting folders, `--name` for naming the container
[2] http://speech.ee.ntu.edu.tw/DSP2021Autumn/hw3/FAQ.html

Homework

Workflow


corpus.txt
test data
character segmentation
segmented corpus
segmented test data
ngram-count
language model
Big5-ZhuYin mapping
mapping
ZhuYin-Big5 mapping
disambig
decoded text

Provided Files

Big5-ZhuYin.map

- a mapping from Chinese character to ZhuYin

corpus.txt

- corpus data

Makefile

- Makefile template

separator_big5.pl

- script used to separate Chinese words

setup.sh

- script used to activate SRILM environment

test_data

- directory for test data

```
dsp_hw3
├── Big5-ZhuYin.map
├── corpus.txt
├── Makefile
├── separator_big5.pl
├── setup.sh
└── test_data
    └── ...
```

Setup

To activate SRILM environment, simply use the provided script:

```
source setup.sh
```

You have to modify *SRILM_REP_PATH* and *MACHINE_TYPE* on your own if not using provided docker image.

Character Segmentation

Separate Chinese words into characters:

```
perl separator_big5.pl $1 > $2
```

$1 input text file

$2 output segmented file

- 魔法 科 高中 的 劣等生 → 魔 法 科 高 中 的 劣 等 生
- 大家 都 很 有 進展 → 大 家 都 很 有 進 展
- 數位 語音 處理 概論 → 數 位 語 音 處 理 概 論

Language Model

Build the language model:

```
ngram-count -text $1 -write $2 -order $3
```

- **$1** input text file
- **$2** output count file
- **$3** order of n-gram

```
ngram-count -read $1 -lm $2 -order $3 -unk
```

- **$1** input count file
- **$2** output language model file
- **$3** order of n-gram
- **unk** view OOVs as <unk> instead of removing them

Language Model Format

- count file

```
夏  11210
俸  267
鴿  7
衹  1
微  11421
```

- language model file

```
\data\
ngram 1 = 6868
ngram 2 = 1696830
\1-grams:
-1.178429 </s>
-99 <s> -2.738217
-1.993207 — -1.614897
```

ZhuYin-Big5 Map

Create a ZhuYin-Big5 mapping from Big5-ZhuYin mapping:

Big5-ZhuYin		ZhuYin-Big5	
一	ㄧˊ / ㄧˋ / ㄧ _	ㄅ	八 匕 卜 …
乙	ㄧˇ	八	八
丁	ㄉㄧㄥ _	匕	匕
	…		…
長	ㄔㄤˊ / ㄓㄤˇ	ㄆ	仆 匹 片 丕 …
行	ㄒㄧㄥˊ / ㄏㄤˊ	仆	仆
	…		…

- Be aware of **polyphones** (破音字).
- Do not forget Big5-Big5 mapping, e.g. 八 八, 匕 匕
- **One tab** must be used to separate the first column and the second.
- **One space** must be used to separate each observation.
- Arbitrary order of the entries and the observations is allowed and **SHOULD NOT** affect the output of disambig

Decoding

Decode the data by:

1. disambig provided by SRILM

   ```
   disambig -text $1 -map $2 -lm $3 -order $4 > $5
   ```

   - $1 segmented file to be decoded
   - $2 ZhuYin - Big5 mapping
   - $3 language model
   - $4 order of language model
   - $5 output file

2. your own disambig (MyDisambig)
   - Please implement it by Viterbi algorithm.
   - Bigram is required while trigram is for bonus.
   - Details will be described in *Requirements*.

Requirements

Makefile Format

Your programs should be compiled by Makefile with:

```
make SRIPATH=$1 MACHINE_TYPE=$2
```

$1 SRILM path

$2 machine type

In provided docker image, *SRIPATH* is */root/srilm-1.5.10* and *MACHINE_TYPE* is *i686-m64*.

At least one executable named *mydisambig* should be compiled.

Mapping Program Format

You are allowed to use **C**, **C++**, or **Python** in this part. TA will run your program by the following command:

```
make map FROM=$1 TO=$2
```

$1 Big5-ZhuYin mapping file (input)

$2 ZhuYin-Big5 mapping file (output)

If you are using *C* or *C++*, your mapping program should be compiled in this or previous step.

MyDisambig Format

You are required to implement your own bigram disambig using *C++*. It will be executed by the following command:

```
./mydisambig $1 $2 $3 $4
```

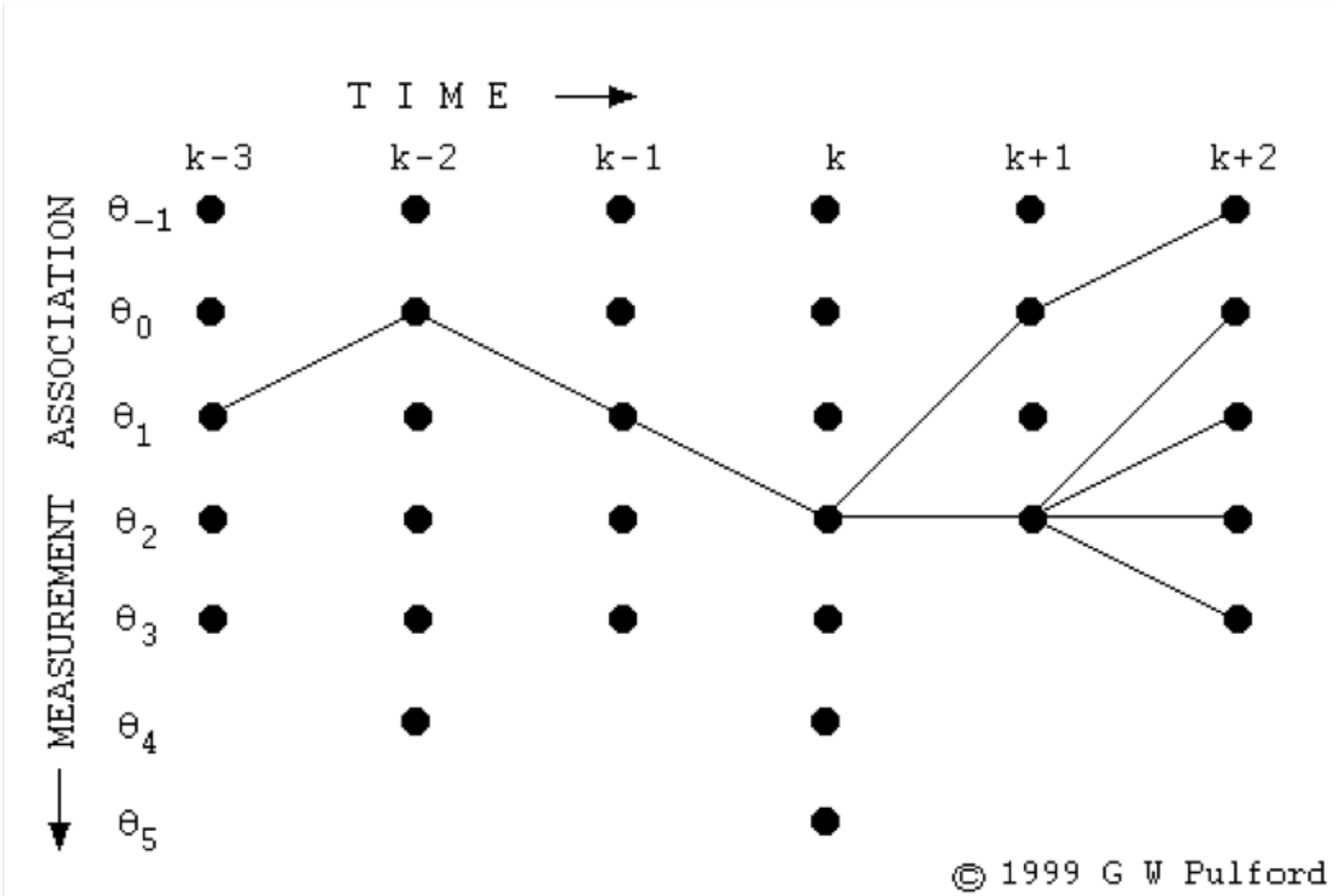
- **$1** segemented file to be decoded
- **$2** ZhuYin-Big5 mapping
- **$3** language model
- **$4** output file

The output format of your program should be **exactly the same as** that of SRILM disambig.

Hard-coded path in your source code is forbidden and you are not allowed to change the number or the order of the command-line arguments.

Hint for MyDisambig

Use dynamic programming (Viterbi).
The vertical axes are candidate characters.



SRILM Output Format

Here is an example of SRILM disambig output:

<s> 保 持 社 交 距 離 </s>

- There are always a <s> at the beginning and a </s> at the end.
- There is exactly one space between each token.

Restrictions

- Here are some useful SRILM libraries you may use:
  - *$SRIPATH*/include/File.h
  - *$SRIPATH*/include/Ngram.h
  - *$SRIPATH*/include/Vocab.h
  - *$SRIPATH*/include/VocabMap.h
- If you need other libraries, please contact us to ask for permission.
- Usage of the source code of *disambig* and Viterbi algorithm are **strictly forbidden**.

Hints

- A Chinese character in Big5 is always encoded with 2 bytes, namely, `char[2]` in C++.
- Be careful not to change the encoding of data, otherwise your program may fail to parse Big5 encoded files when grading.

Report Format

Write a report (at most **two pages**) in **PDF** format, name it *`report.pdf`* and submit with your source code.

Your report should at least include the following contents:

- your name and student ID
- what you observed (e.g., disambig vs. MyDisambig)
- what you have done (e.g., trigram decoding)

If implementing trigram decoding, you should describe it in a detailed manner. The bonus point will be granted according to both program performance and description in report.

Submission Format

Your submission should be a **ZIP** file and be uploaded to CEIBA. Its file structure should be the same as the following:

```
<zip_file>
└── hw3_<student_id>
    ├── Makefile
    ├── report.pdf
    ├── inc
    │   └── [*.h, *.hpp]
    └── src
        └── [*.c, *.cc, *.cpp, *.py]
```

- *Makefile*, *report.pdf*, *inc/*, and *src/* are **MUST HAVE**, even if you don't have any header files.
- All of your source code must be placed under *inc/* and *src/*.
- **DO NOT** create any subdirectory in *inc/* and *src/*.
- *<student_id>* should be in lowercase, e.g. *r01234567*.

Grading

Grading Method & Environment

Your mapping and disambig program will be tested respectively.

Mapping is allowed to run for **30 seconds** while **MyDisambig** is required to be finished within **1 minute** for each input data. Programs will be interrupted when time limit exceeds.

For those who want to get the bonus points, your **trigram Mydisambig** must also be finished within **1 minute**.

The environment TA will use is the same as the provided docker image except for **different** SRILM path.

Grading Policy

$$\text{SCORE} = (\text{F} + \text{M} + \text{Mapping} + \text{MyDisambig} + \text{Report} + \text{Trigram})$$

Item	Score	Description
F	0	10 points will be deducted for incorrect file format
M	0	10 points will be deducted for unmakable Makefile.
Mapping	15	Correctly generating mapping in time for full credit; otherwise you will get 0.
MyDisambig	70	35 for successful execution in time, and 35 for accuracy.
Report	15	You will get 0 if it is more than 2 pages.
Trigram	10	Bonus for trigram MyDisambig.

Late Submission

Due on 23:59, December 17, 2021

You are still allowed to submit after the due date. The penalty for late submission is an exponential decay with decay rate 1.5%[3] of the maximum grade applicable for the assignment, for each hour that the assignment is late.

An assignment submitted more than 3 days after the deadline will have a grade of zero recorded for that assignment.

$$\text{SCORE}_{final}(\text{hr}) = \begin{cases} \text{SCORE}_{original} \times 0.985^{\text{hr}} & , \ \text{hr} \leqslant 72 \\ 0 & , \ \text{hr} > 72 \end{cases}$$

[3] less than 70% after 24 hrs, 48% for 48 hrs and 33% for 72 hrs

DO NOT CHEAT

Any form of cheating, lying, or plagiarism will not be tolerated.

Contact TAs

Should you have any question or need help,

- Please read the FAQ[4] first.
- Send email to *ntu-dsp-2021-ta@googlegroups.com* with "**[HW3]**" as the subject line prefix.

張宇航	Mon.	10:00 - 12:00
門玉仁	Wed.	12:10 - 14:10

Office hours

(TA 門玉仁 will offer help with environment related questions)

[4] http://speech.ee.ntu.edu.tw/DSP2021Autumn/hw3/FAQ.html