ADL x MLDS 2017 Fall HW1 - Sequence Labeling

2017/10/02
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Outline

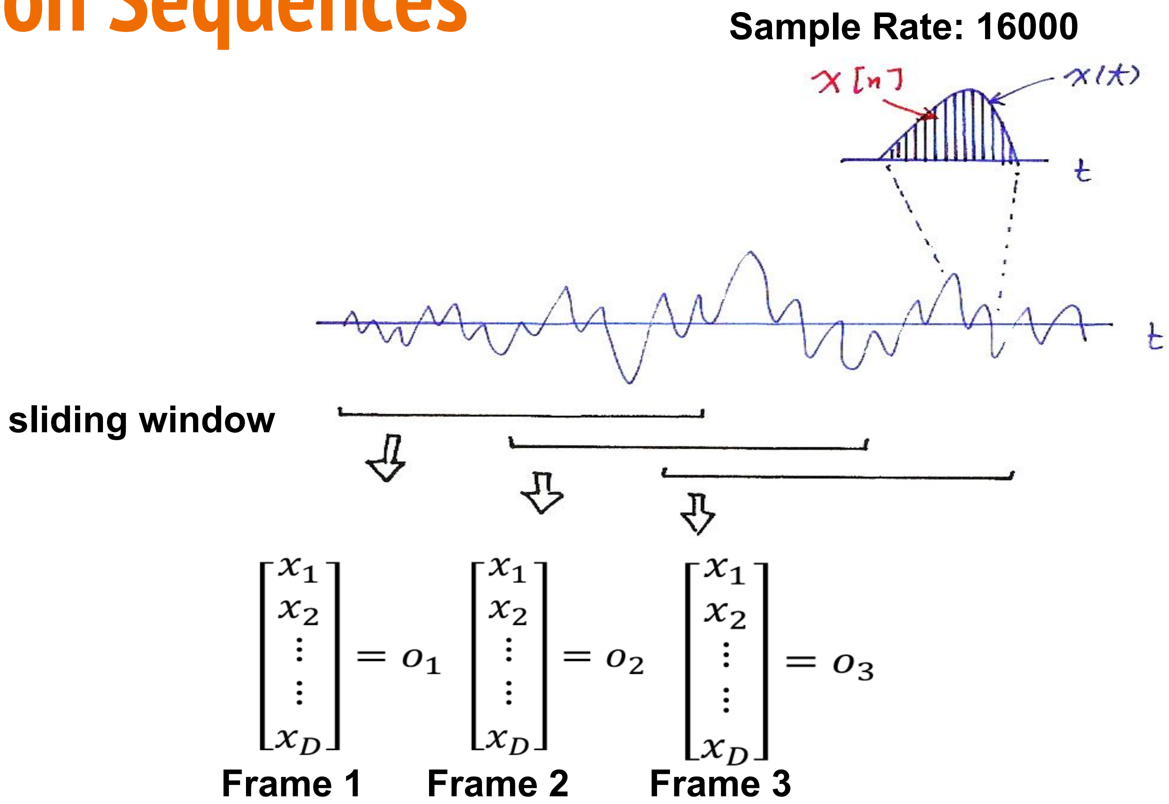
- Task Description
    - Phone sequence labeling
    - TIMIT Dataset and Data Format
- Recurrent Neural Networks & Convolutional Neural Networks
- Kaggle
- Grading
- Format and Submission Rules

Speech Recognition

- In speech processing
  - Each word consist of syllables
  - Each syllables consist of phone
  - “青色” → “青(ㄑㄧㄥ)色(ㄙㄜˋ)” → ”ㄑ” (syllables)
    青:TSI --I –N (phone)
    色:S--@ (phone)

- Each time frame, with an observance (vector) mapped to a phone.

Observation Sequences



Sample Rate: 16000

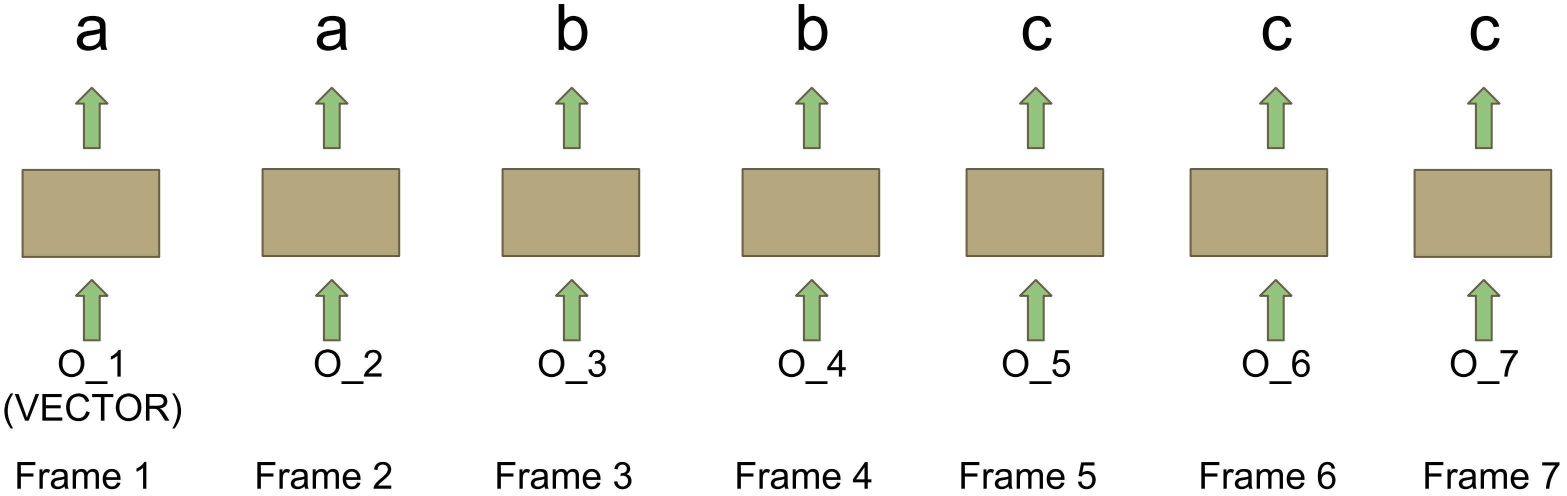
sliding window

$$\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ \vdots \\ x_D \end{bmatrix} = o_1 \quad \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ \vdots \\ x_D \end{bmatrix} = o_2 \quad \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ \vdots \\ x_D \end{bmatrix} = o_3$$

Frame 1 Frame 2 Frame 3

ref: DSP lect 2.0

Framewise Prediction



Phone Prediction

- What really matters in speech recognition is the **final phone sequence**, not the framewise alignment.
- That is, the final evaluation in this homework is based on the **phone sequence**.
- **You have to trim the frame-level sequence into phone sequence.**

Trimmimg on Framewise Sequence (1/2)

- **Remove consecutive duplicate labels**

Framewise prediction: {a, a, b, b, c, c, c}

Phone prediction : {a, b, c}

You need to report result in phone sequence

Trimmimg on Framewise Sequence (2/2)

- **Remove only leading and tailing silence**

  Framewise prediction: {<sil>, <sil>, a, a, b, <sil>, c, c, <sil>}

  Phone prediction : {a, b, <sil>, c}

You need to report result in phone sequence

Dataset (1/2)

- **TIMIT**(**T**exas **I**nstrument and **M**assachusetts **I**nstitute of **T**echnology)
- Well-transcribed speech of American English speakers of different sexes and dialects.
- Designed for the development and evaluation of ASR systems.
- Features
  - MFCC: 39 dim
  - FBank: 69 dim

Dataset (2/2)

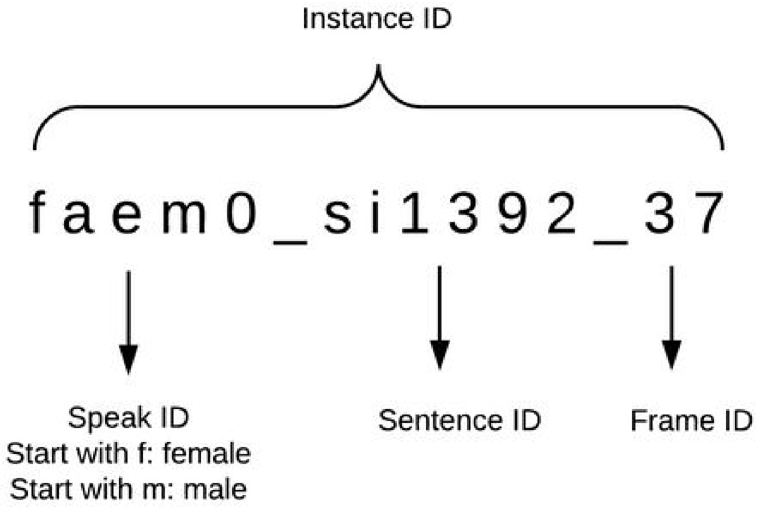
Each instance consist of 3 parts: Speaker ID, Sentence ID, Frame ID

Ex:

Speaker ID: faem0

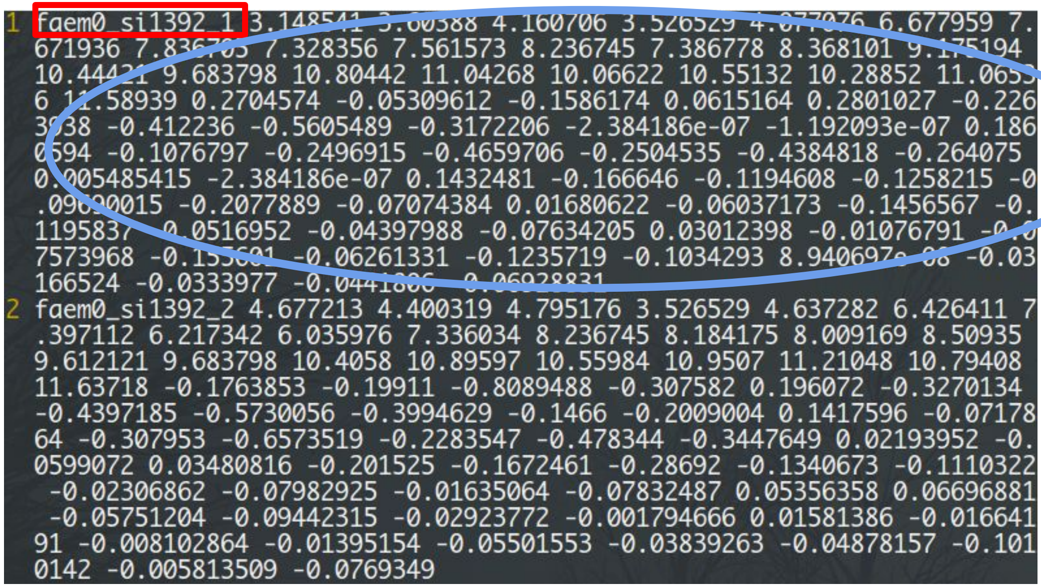
Sentence ID: si1392

Frame ID: 37



Data Format (1/3)

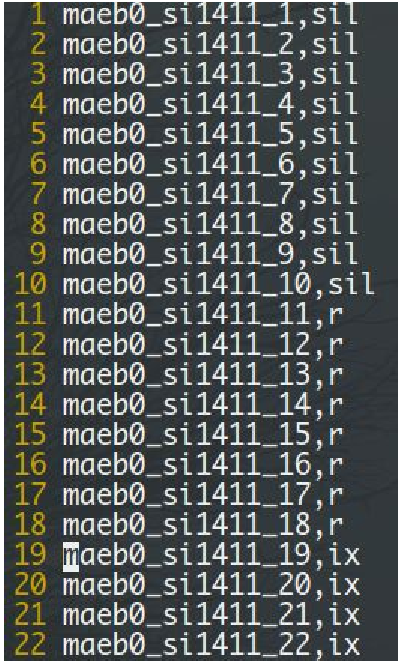
- WAV file: Speaker-Sentence_ID + .wav → Check by your ears
- ARK file: Instance ID + features



```
faem0_si1392_1 3.148541 3.60388 4.160706 3.526529 4.077076 6.677959 7.
671936 7.836705 7.328356 7.561573 8.236745 7.386778 8.368101 9.175194
10.44421 9.683798 10.80442 11.04268 10.06622 10.55132 10.28852 11.0653
6 11.58939 0.2704574 -0.05309612 -0.1586174 0.0615164 0.2801027 -0.226
3938 -0.412236 -0.5605489 -0.3172206 -2.384186e-07 -1.192093e-07 0.186
0594 -0.1076797 -0.2496915 -0.4659706 -0.2504535 -0.4384818 -0.264075
0.005485415 -2.384186e-07 0.1432481 -0.166646 -0.1194608 -0.1258215 -0
.09690015 -0.2077889 -0.07074384 0.01680622 -0.06037173 -0.1456567 -0.
1195837 -0.0516952 -0.04397988 -0.07634205 0.03012398 -0.01076791 -0.0
7573968 -0.155601 -0.06261331 -0.1235719 -0.1034293 8.940697e-08 -0.03
166524 -0.0333977 -0.0441806 -0.06928831
faem0_si1392_2 4.677213 4.400319 4.795176 3.526529 4.637282 6.426411 7
.397112 6.217342 6.035976 7.336034 8.236745 8.184175 8.009169 8.50935
9.612121 9.683798 10.4058 10.89597 10.55984 10.9507 11.21048 10.79408
11.63718 -0.1763853 -0.19911 -0.8089488 -0.307582 0.196072 -0.3270134
-0.4397185 -0.5730056 -0.3994629 -0.1466 -0.2009004 0.1417596 -0.07178
64 -0.307953 -0.6573519 -0.2283547 -0.478344 -0.3447649 0.02193952 -0.
0599072 0.03480816 -0.201525 -0.1672461 -0.28692 -0.1340673 -0.1110322
 -0.02306862 -0.07982925 -0.01635064 -0.07832487 0.05356358 0.06696881
 -0.05751204 -0.09442315 -0.02923772 -0.001794666 0.01581386 -0.016641
91 -0.008102864 -0.01395154 -0.05501553 -0.03839263 -0.04878157 -0.101
0142 -0.005813509 -0.0769349
```

Data Format (2/3)

- LAB file: Instance ID + , + label
- 48 phones
- Map them to 39 phones by **<u>yourselves</u>**



```
maeb0_si1411_1,sil
maeb0_si1411_2,sil
maeb0_si1411_3,sil
maeb0_si1411_4,sil
maeb0_si1411_5,sil
maeb0_si1411_6,sil
maeb0_si1411_7,sil
maeb0_si1411_8,sil
maeb0_si1411_9,sil
maeb0_si1411_10,sil
maeb0_si1411_11,r
maeb0_si1411_12,r
maeb0_si1411_13,r
maeb0_si1411_14,r
maeb0_si1411_15,r
maeb0_si1411_16,r
maeb0_si1411_17,r
maeb0_si1411_18,r
maeb0_si1411_19,ix
maeb0_si1411_20,ix
maeb0_si1411_21,ix
maeb0_si1411_22,ix
```

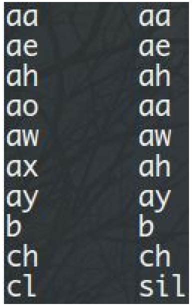
Data Format (3/3)

- MAP file: 2 mapping

  (1) 48 phones - 39 phones

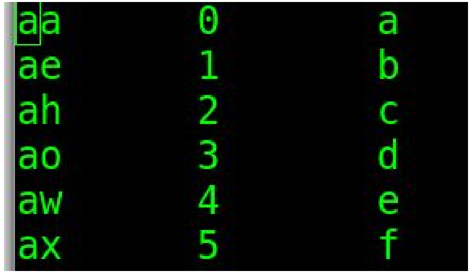
  (2) 48 phones - 48 English characters

Delimiter: '\t'



```
aa      aa
ae      ae
ah      ah
ao      aa
aw      aw
ax      ah
ay      ay
b       b
ch      ch
cl      sil
```

MAP (1)

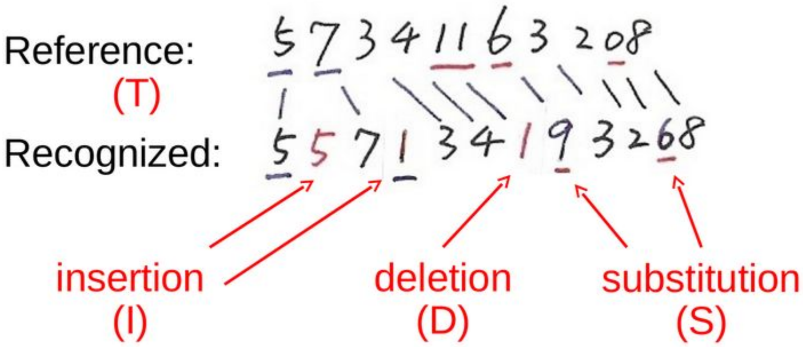


```
aa      0       a
ae      1       b
ah      2       c
ao      3       d
aw      4       e
ax      5       f
```

MAP (2)

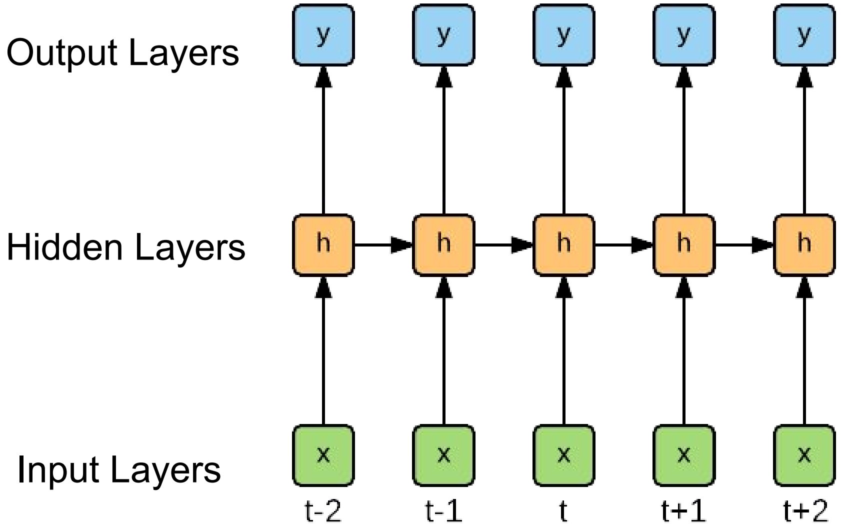
Evaluation

- **Average Phone Sequence Edit Distance**
  - Compare your trimmed phone sequence with correct ones
- **Edit Distance = Insertion + Deletion + Substitution**
- Consider the following case, edit distance = I + D + S = 2 + 1 + 2 = 5



Recurrent Neural Networks

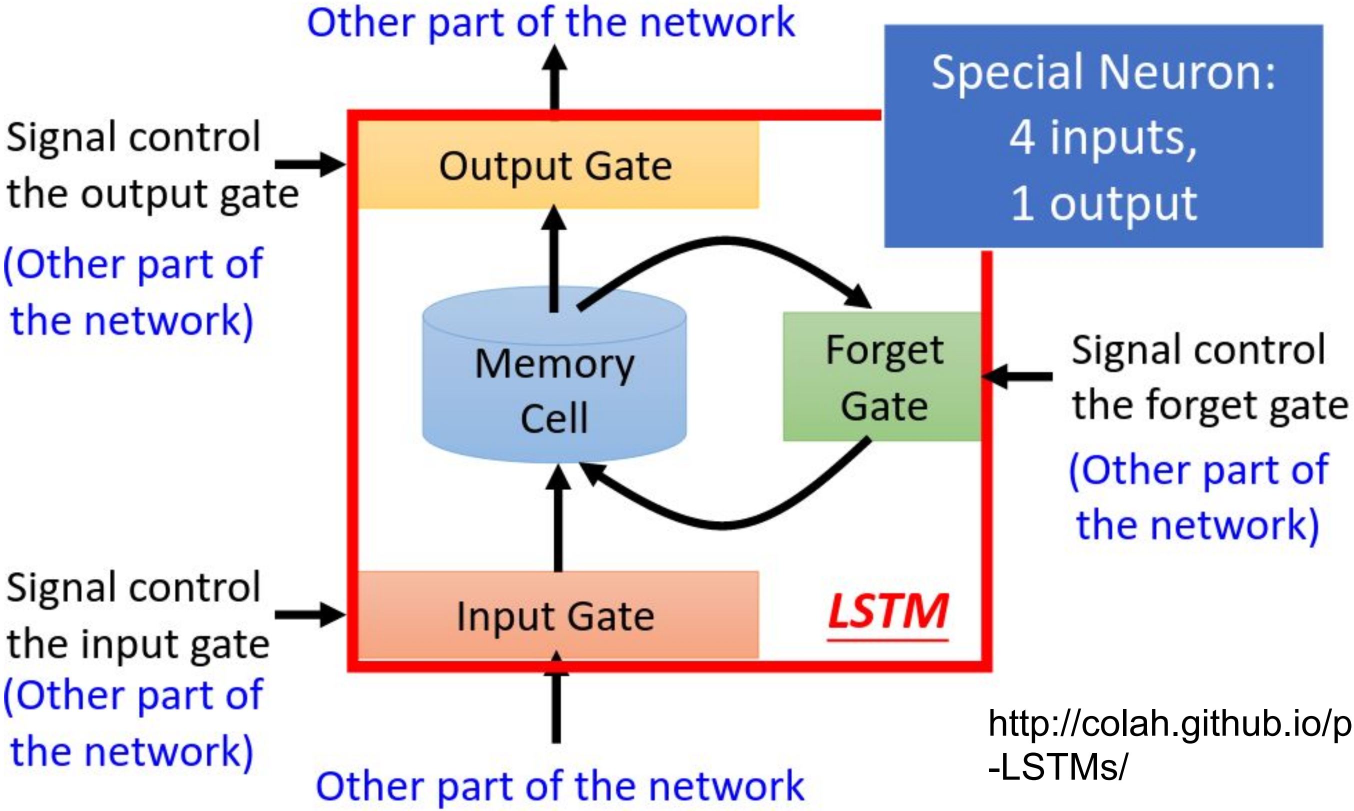
RNN - Unfolded View



RNN

- With Hidden Layer (Memory Layer), RNN can learn more long-term information.
    - **Sequential Information.**
- With **LSTM** gated-extension, the RNN can learn longer and longer.

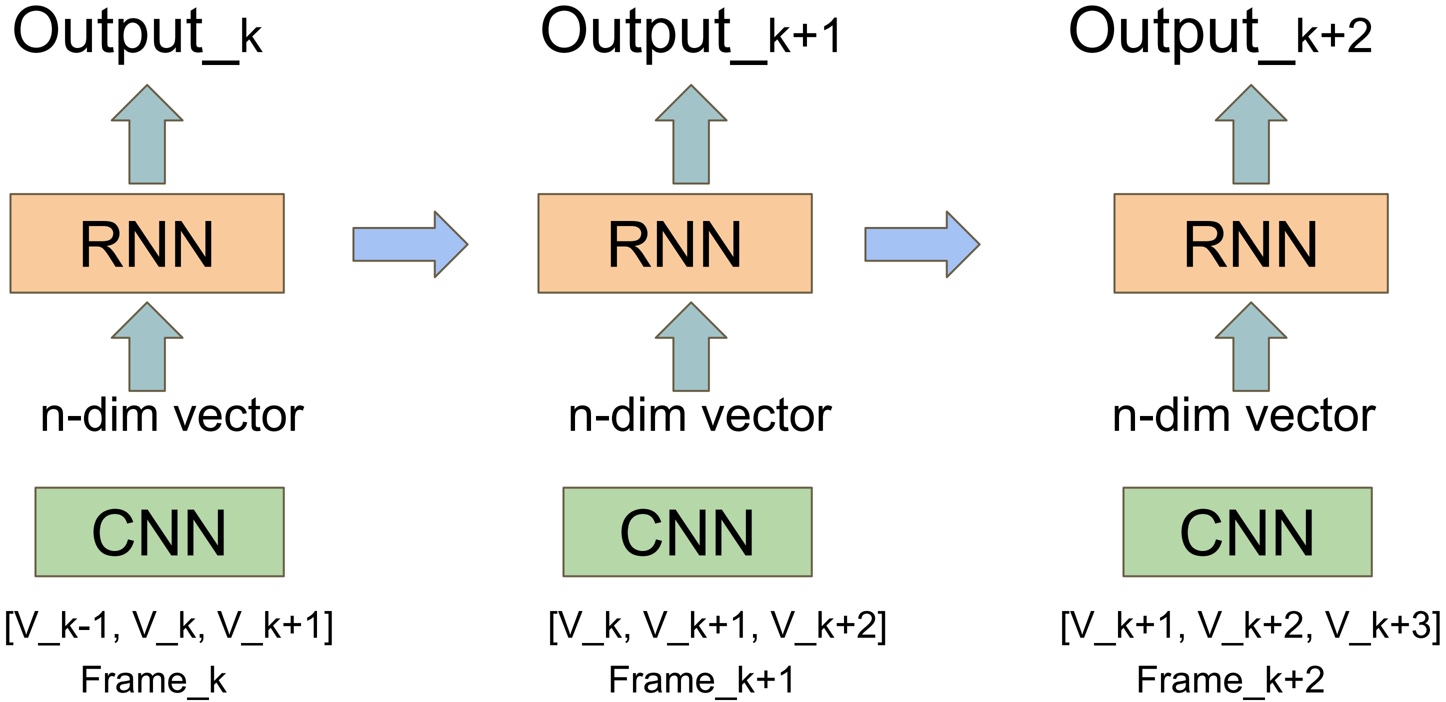
Long Short-term Memory (LSTM)



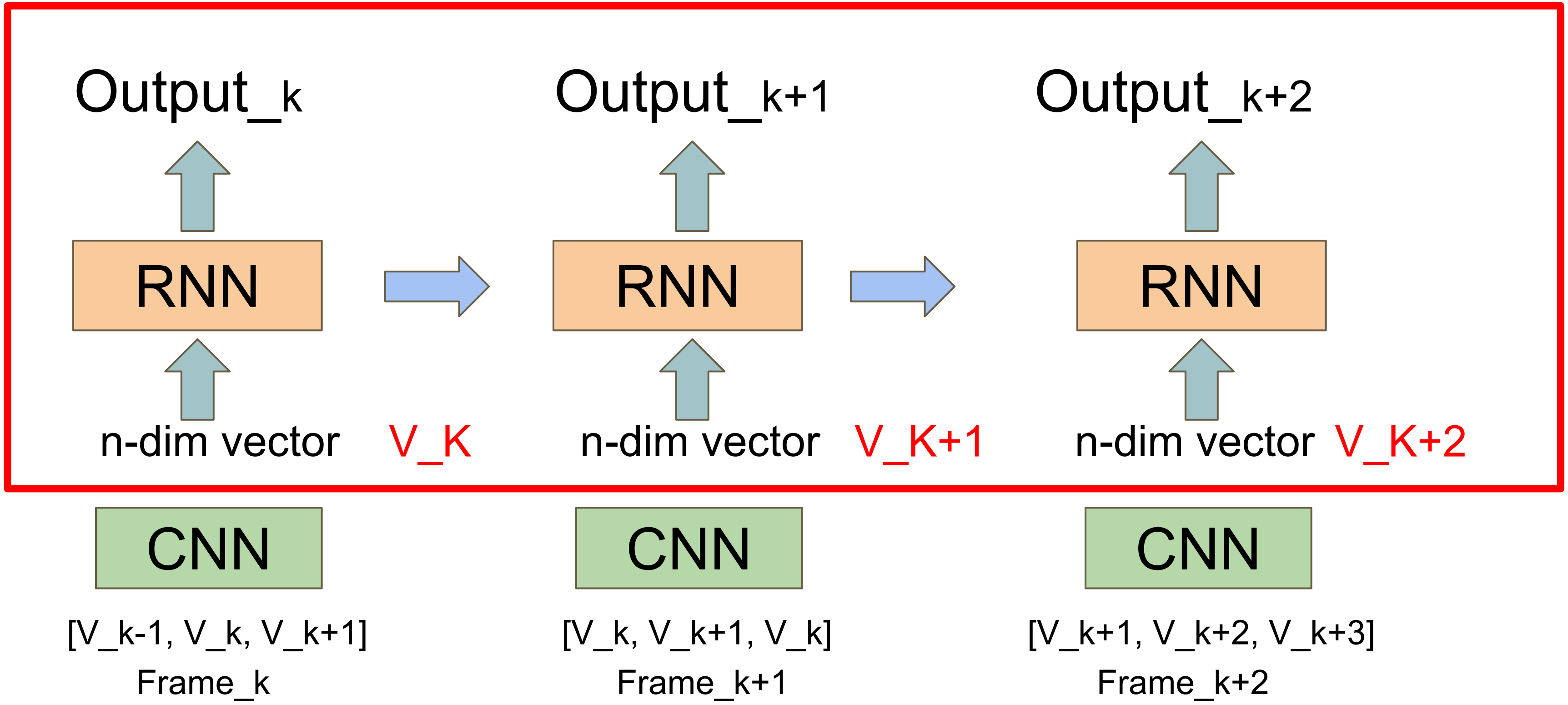
http://colah.github.io/posts/2015-08-Understanding-LSTMs/

Convolutional Neural Network

Jointly train RNN with CNN



Jointly train RNN with CNN



Output_k

Output_k+1

Output_k+2

RNN

RNN

RNN

n-dim vector V_K

n-dim vector V_K+1

n-dim vector V_K+2

CNN

CNN

CNN

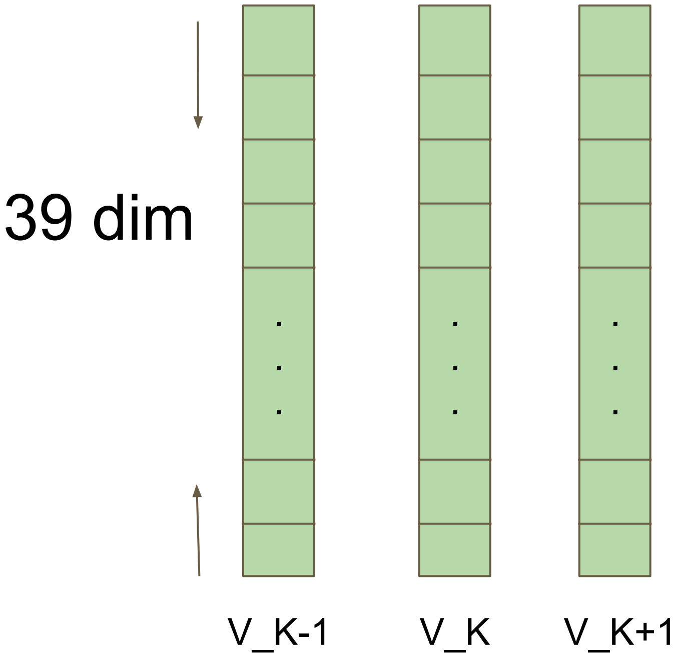
[V_k-1, V_k, V_k+1]
Frame_k

[V_k, V_k+1, V_k]
Frame_k+1

[V_k+1, V_k+2, V_k+3]
Frame_k+2

CNN on acoustic features

Take feature MFCC for example:

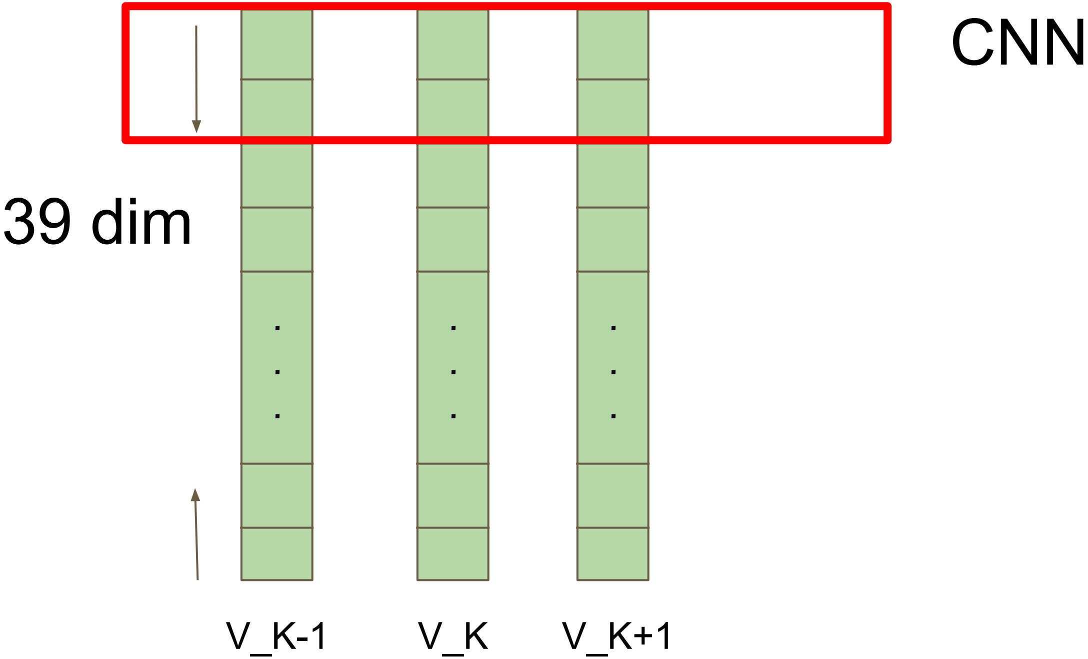


39 dim

V_K-1 V_K V_K+1

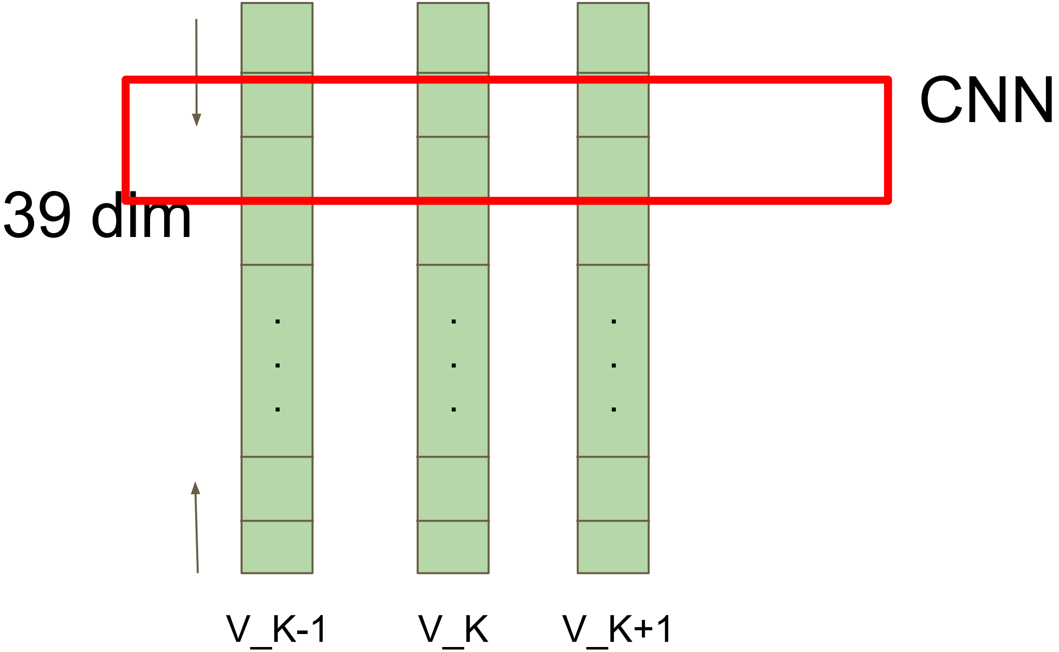
CNN on acoustic features

Take feature MFCC for example:



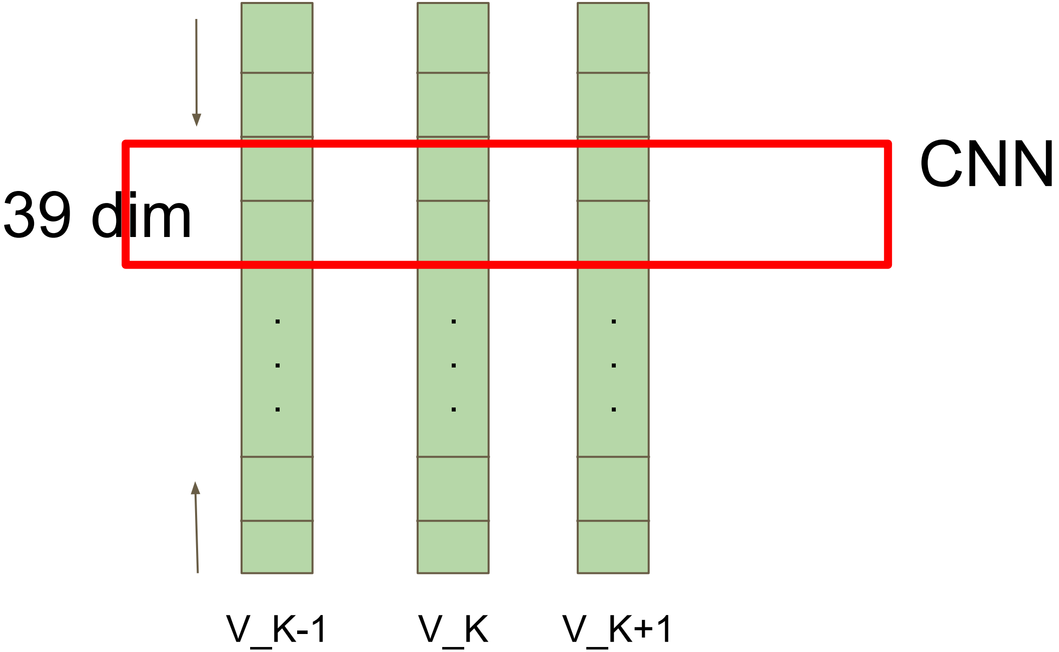
CNN on acoustic features

Take feature MFCC for example:



CNN on acoustic features

Take feature MFCC for example:



Try different experiment settings and write down your observation in the report !

CNN Lectures

- Machine Learning 2016 Fall

https://www.youtube.com/watch?v=FrKWiRv254g

- Tóth, László. "Convolutional Deep Maxout Networks for Phone Recognition”, Interspeech, 2014

HW Rules

HW Rules

- Please write shell script to run your code.
- There should be hw1_rnn.sh, hw1_cnn.sh, hw1_best.sh
- Please follow the script usage below:
  - ./hw1_rnn.sh $1 $2
  - ./hw1_cnn.sh $1 $2
  - ./hw1_best.sh $1 $2
  - $1: the data directory, $2: output filename
- Ex: ./hw1_best.sh myData/ best.csv

HW Rules

- Please implement RNN-based to fulfill the task
- Please also implement CNN+RNN-based to fulfill the task
- Please use python with version >= 3.5
- Please do not use extra dataset
- Allowed package includes:
  - PyTorch v0.2.0
  - tensorflow r1.3
  - Keras 2.0.7
  - MXNet 0.11.0
  - CNTK 2.2

Kaggle

Kaggle (1/3)

- Kaggle: https://www.kaggle.com/t/0d61e84f89594f998b12d999fa4b4d5f
- competition will started at **2017/10/5 12:00 (GMT+8).**
- Please create **ONE** account using your school mail (Ex: NTU)
- For students taking this class, your title on leaderboard should start with **your student ID**
    - Ex: b03xxxxxx_SamIsTheBest
- At most **5** submissions per day
- Indivisual task, do not team up!
- No score counted if
    - you create more accounts to get more submissions == cheating!
    - your title does not conform to the naming rules

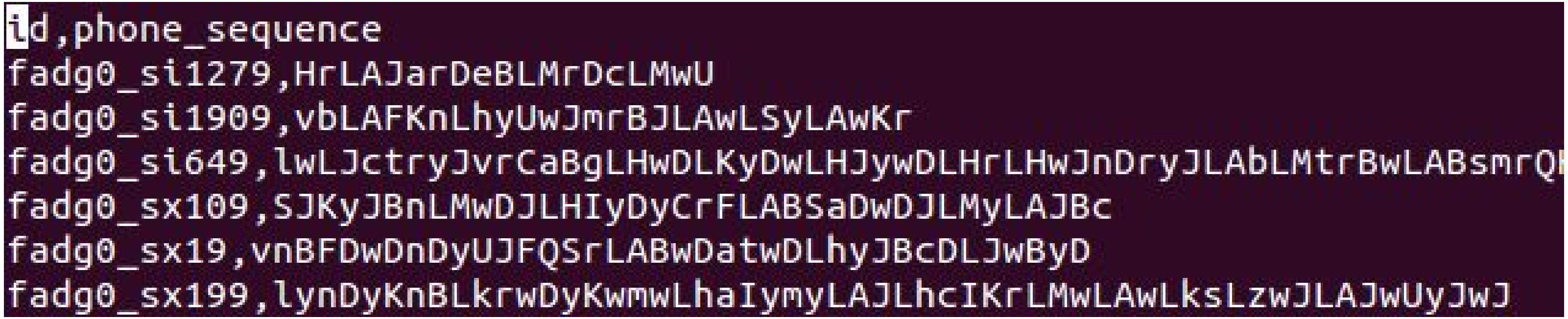
FAIL

Kaggle (2/3)

- Testing set is divided into two sets: **public** and **private**
- Your performance on leaderboard during the competition is based on the public set
- After deadline, the private set will be evaluated
- Remember to choose **2 submissions** for the final evaluation before deadline, otherwise Kaggle will select for you
- Please do not attempt to fit the public set

Kaggle (3/3)

- Submission format: a **.csv** file with then content as below
- Remember to map the framewise output to 39 phones
- Remember to map phones to English letter
- Remember to trim <sil>
- With header row: “id,phone_sequence”
- Instance ID + , + predicted phone sequence



```
id,phone_sequence
fadg0_si1279,HrLAJarDeBLMrDcLMwU
fadg0_si1909,vbLAFKnLhyUwJmrBJLAwLSyLAwKr
fadg0_si649,lwLJctryJvrCaBgLHwDLKyDwLHJywDLHrLHwJnDryJLAbLMtrBwLABsmrQ
fadg0_sx109,SJKyJBnLMwDJLHIyDyCrFLABSaDwDJLMyLAJBc
fadg0_sx19,vnBFDwDnDyUJFQSrLABwDatwDLhyJBcDLJwByD
fadg0_sx199,lynDyKnBLkrwDyKwmwLhaIymyLAJLhcIKrLMwLAwLksLzwJLAJwUyJwJ
```

Grading

Grading Policy

I. Baseline (6%)

II. Ranking (8%)

III. Report (4%)

IV. Bonus (2%).

V. Notice

Grading Policy -- Baseline&Ranking

- Pass the public baseline (3%)
- Pass the private baseline (3%)
- Ranking (8%) For those passing the private baseline, your score will be linearly grade, rounded to the 2nd decimal place
  - Ex: if 100 people pass the baseline, you will get 6 points if you're at 25th place.
- We will run your code to make sure your leaderboard performance is aligned with your submission

Grading Policy -- Report(4%)

- Do not exceed **4** pages and written in Chinese
- Model description (2%)
  - RNN (1%)
  - RNN+CNN (1%)
- How to improve your performance (1%)
  - Write down the method that makes you outstanding
  - Describe the model or technique (0.5%)
  - Why do you use it (0.5%)
- Experimental results and settings (1%)
  - Compare and analyze the results between RNN and CNN (0.5%)
  - Compare and analyze the results with other models (0.5%)
    - other models can be variant of basic RNN, like LSTM, or some novel ideas you use

Grading Policy -- Bonus(2%)

- TAs will select about 5 persons, according to both **creativity** and **performance** (top 10%) for introducing your model during the class
- If you are chosen, you have to present in order to get the bonus

Grading Policy -- Notice

- Please fill the late submission form first only if you will submit HW late
- Please push your code before you fill the form
- There will be 25% penalty per day for late submission, so you get 0% after four days
- You can still upload your result on Kaggle, although it won’t be counted in your grade

- You get 0% if the required script has bug.
    - If the error is due to the format issue, please come to fix the bug at the announced time, or you will get 10% penalty afterwards

Submission Rules

Submission Rules

- Please refer to this link **first**.
- Create hw1 directory under ADLxMLDS2017
- Under hw1, there should be:
    - report.pdf
    - **your_rnn_model, your_cnn_model, your_best_model**
    - hw1_rnn.sh // should run your RNN model
    - hw1_cnn.sh // should run your CNN+RNN model
    - hw1_best.sh // should run your best-performed model
    - model_rnn.py, model_cnn.py, model_best.py and other necessary files
    - *In model_rnn.py, model_cnn.py and model_best.py should include your training codes.
- Please do not upload TIMIT dataset to Github
- If your model are too big for github, upload to a cloud space and write it in your script to download the model
- Your script should be done within 10 mins (include preprocessing) excluding model donwloading

Deadline

1. Kaggle deadline: **2017/10/28 12:00 (GMT+8)**
2. Github code & report deadline: **2017/10/28 23:59 (GMT+8)**

FAQ

Q1: 使用的lib 限制

A:

除了拿來training的lib有限制以外，其他lib在使用的時候只要沒有使用外部的dataset都是可以的。並且記得在report中註明使用的lib名稱以及版本。

Ex: sklearn的train, test, split沒有用到助教的其他data，所以可以使用。

Q2: 請問助教會跑training的程式嗎？

A:

不會。我們所規定的十分鐘只包含testing。除非我們認為有必要就會請你們來跑training的code。

Q3: Dataset在哪裡下載？

A:

Dataset可以從Kaggle上下載。

Q4: 執行的時候助教要怎麼知道我是使用哪一種feature?

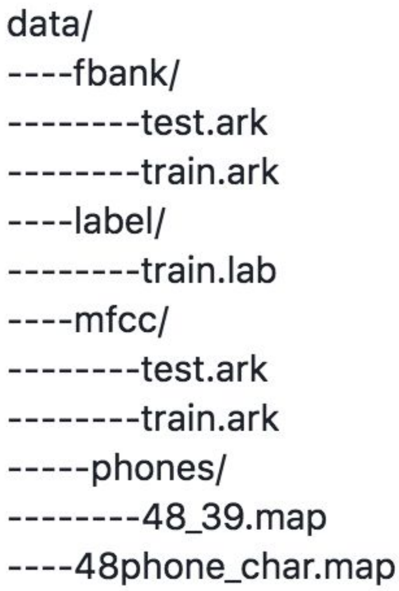
A:

在助教的電腦上，data directory結構如右所示。

而助教在測試的時候，我們argv只會輸入”data/”。所以

同學必須要自己設定好你們需要的檔案路徑讓助教output

正確的答案。



```
data/
----fbank/
---------test.ark
---------train.ark
----label/
---------train.lab
----mfcc/
---------test.ark
---------train.ark
-----phones/
---------48_39.map
----48phone_char.map
```

Q5: Training label和feature的instance_ID順序不一樣，是要自己去對齊嗎？

A:

是的！這部分要麻煩同學自己去對齊！

Q6: 哪些檔案可以上傳到github呢？

A:

任何你們需要的檔案，只要這個檔案不是拿來作弊的（Ex: 外部的dataset），就可以上傳！

Ex: 自己建立的phone2phone, phone2idx這類的dictionary也是可以上傳的！

Q7: 可以上傳前處理的data嗎？

A:

不行。前處理的時間包含在testing的10min之內。

Q8: 有推薦上傳model的平台嗎？

A:

dropbox, google drive都是大家常用的平台。不過推薦大家可以使用gitlab，操作方法與github類似，但是可以上傳大容量的檔案。

FAQ

- If you have other questions,
  - please contact TAs via adlxmlds@gmail.com
  - post your questions on facebook group
  - go to TA office hours
    - 王昱翔 Mon 16:00-17:30 (電二531)
    - 樊恩宇 Fri 10:30-12:00 (明達526)
    - 古志文 Fri 14:30-16:00 (德田524)