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

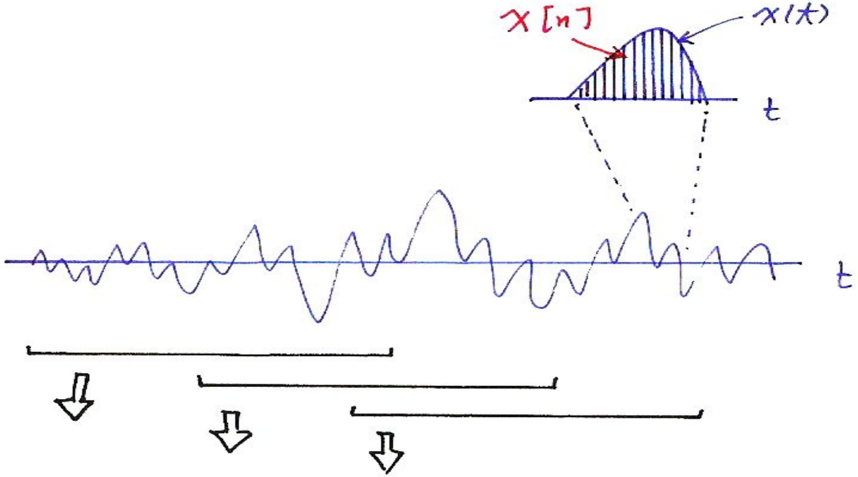
- In speech processing
  - Each word consist of syllables
  - Each syllables consist of phone
  - “青色”→ “青(ㄑㄧㄥ)色(ㄙㄜ、)”→ ”ㄑ” (syllables)
    青：TSI --I –N (phone)
    色：S--@ (phone)

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

Observation Sequences

Sample Rate: 16000

sliding window

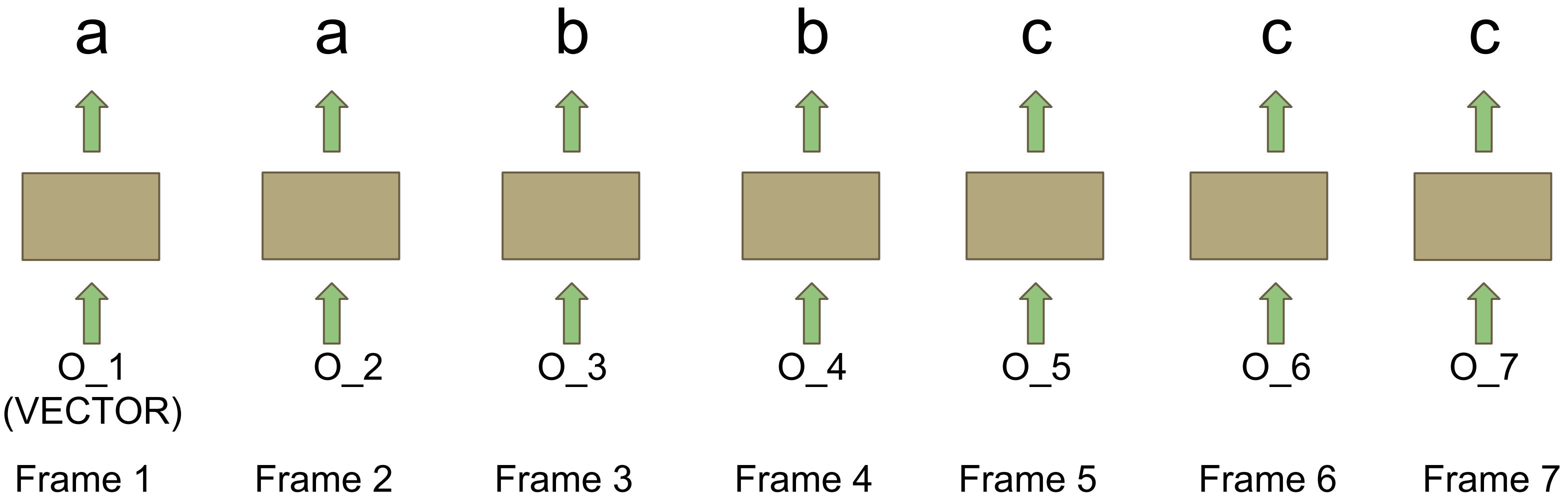


$$\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ \vdots \\ x_D \end{bmatrix} = o_1 \quad \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ \vdots \\ x_D \end{bmatrix} = o_2 \quad \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ \vdots \\ x_D \end{bmatrix} = o_3$$

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)

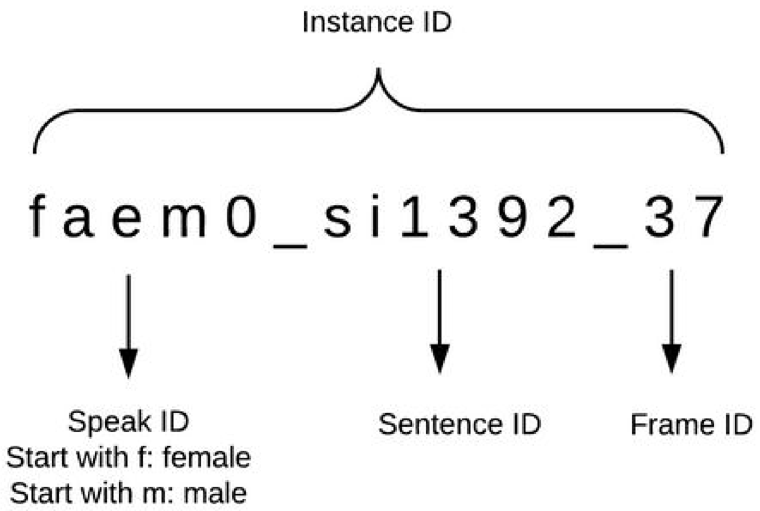
Each instance consist of 3 parts: Speaker ID, Sentence ID, Frame ID

Ex:

Speaker ID: faem0

Sentence ID: si1392

Frame ID: 37



Instance ID

faem0_si1392_37

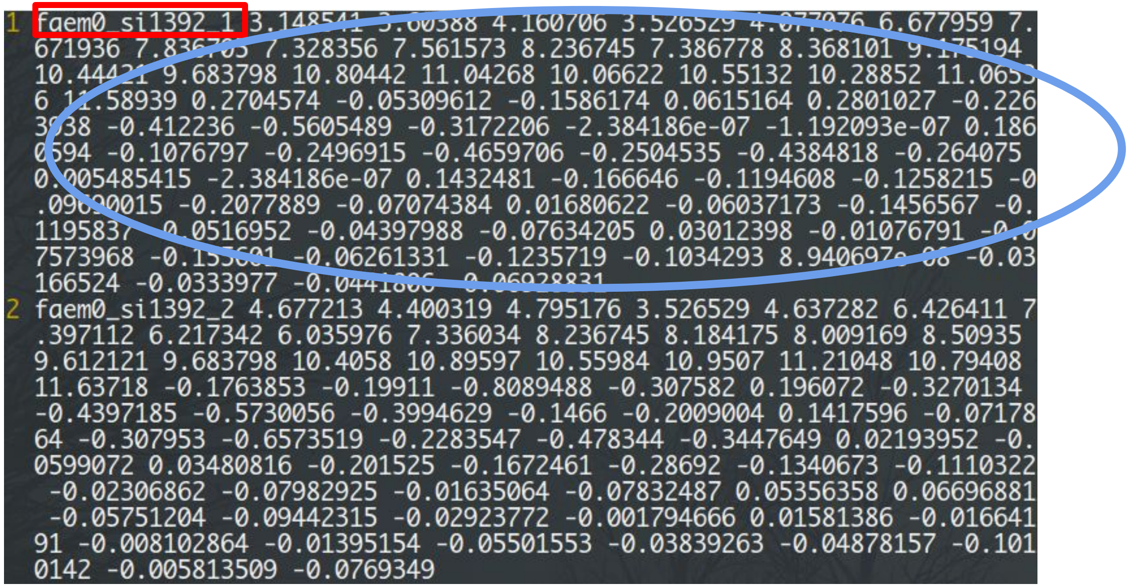
Speak ID
Start with f: female
Start with m: male

Sentence ID

Frame ID

Data Format (1/3)

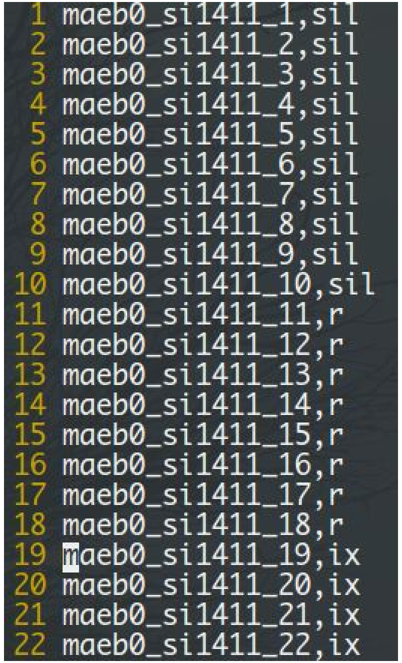
- WAV file: Speaker-Sentence_ID + .wav → Check by your ears
- ARK file: Instance ID + features



```
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 11.0655
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
```

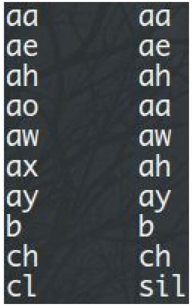
Data Format (3/3)

- MAP file: 2 mapping

  (1) 48 phones - 39 phones

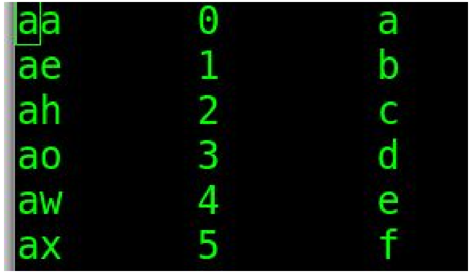
  (2) 48 phones - 48 English characters

Delimiter: ‘\t’



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

MAP (1)

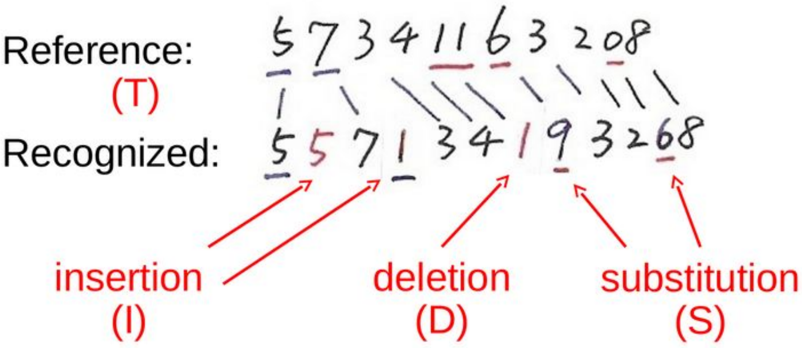


```
aa      0       a
ae      1       b
ah      2       c
ao      3       d
aw      4       e
ax      5       f
```

MAP (2)

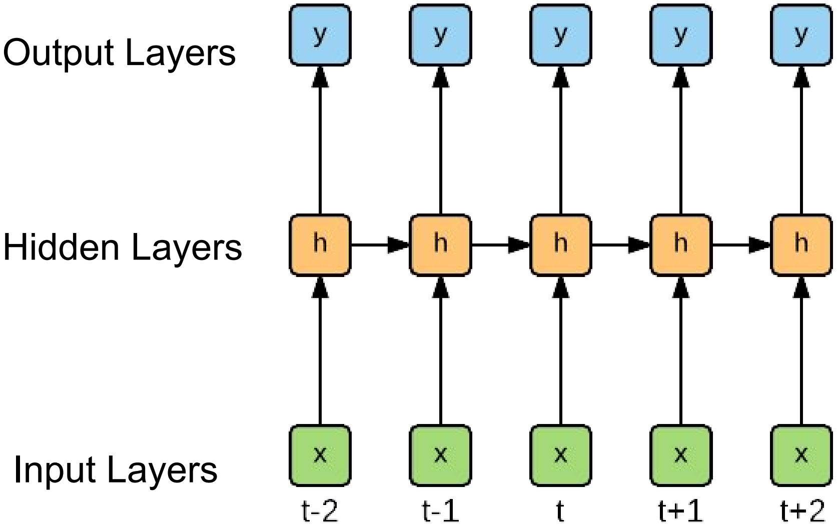
Evaluation

- **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



Output Layers

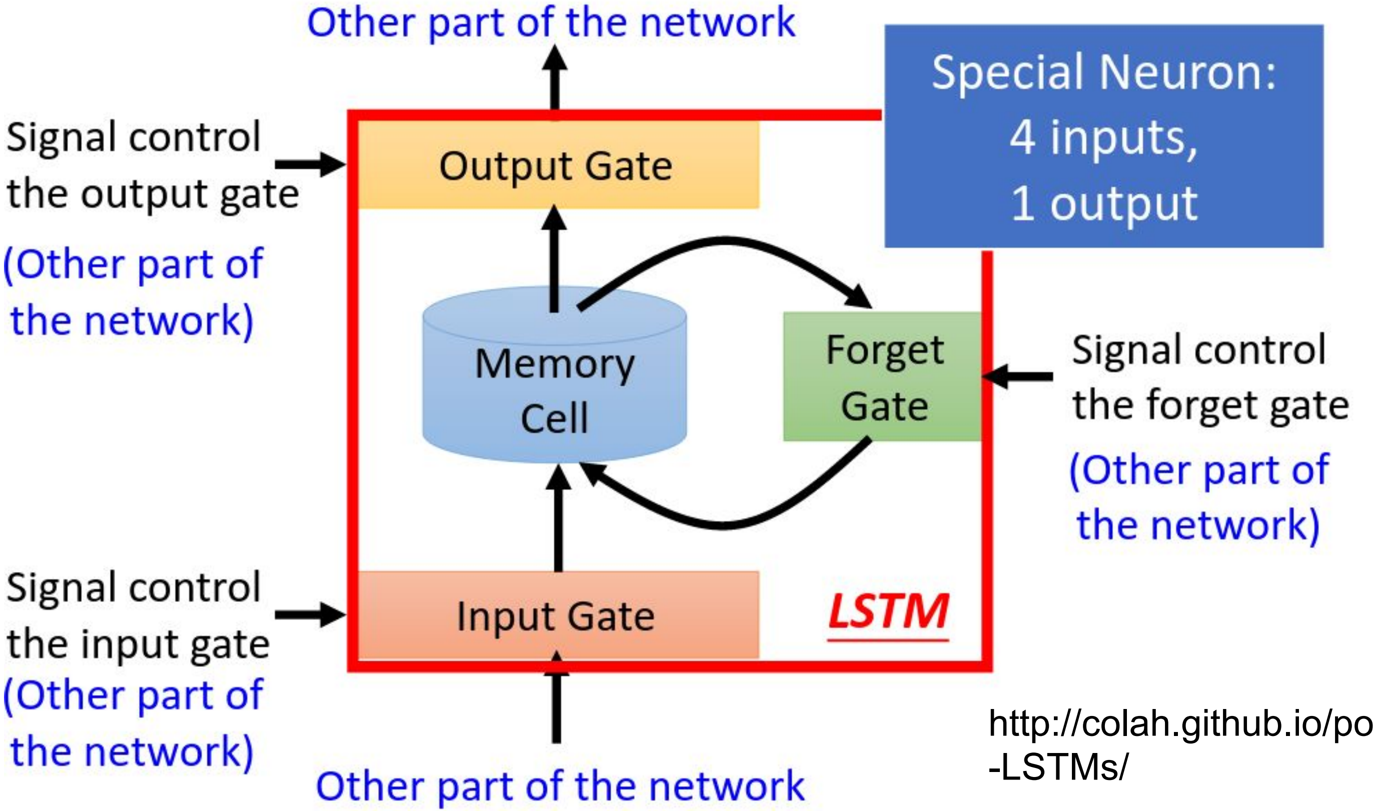
Hidden Layers

Input Layers

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.

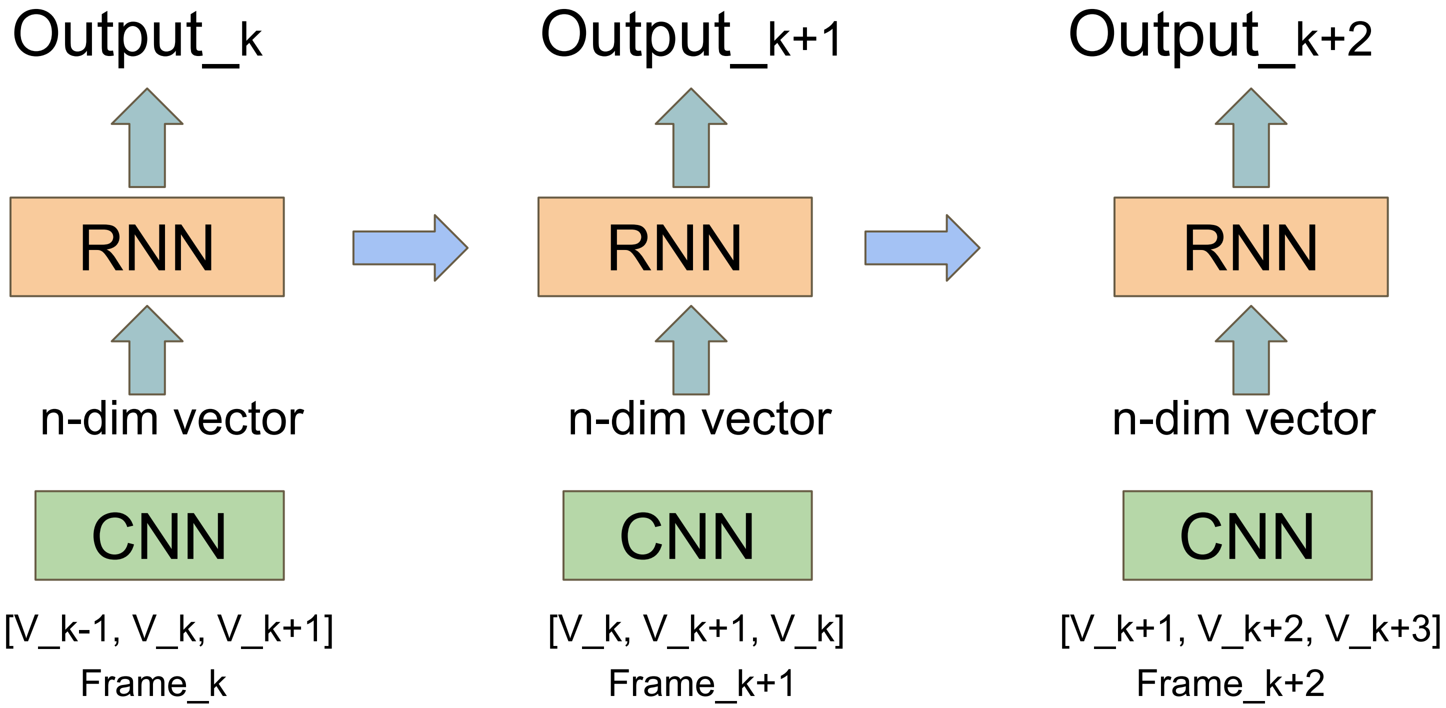
Long Short-term Memory (LSTM)


Other part of the network
Special Neuron:
4 inputs,
1 output
Signal control the output gate
(Other part of the network)
Output Gate
Memory Cell
Forget Gate
Signal control the forget gate
(Other part of the network)
Signal control the input gate
(Other part of the network)
Input Gate
LSTM
Other part of the network

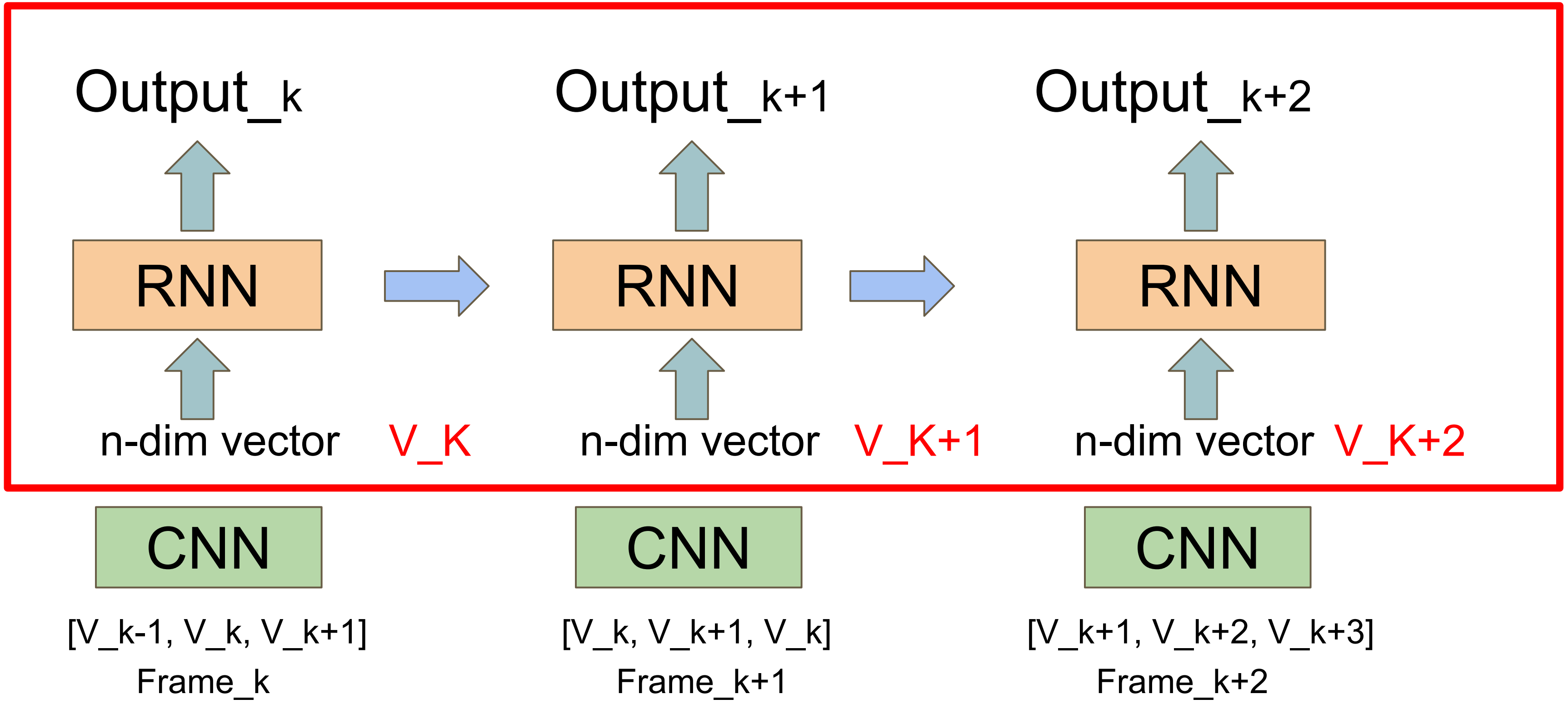
http://colah.github.io/posts/2015-08-Understanding-LSTMs/

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

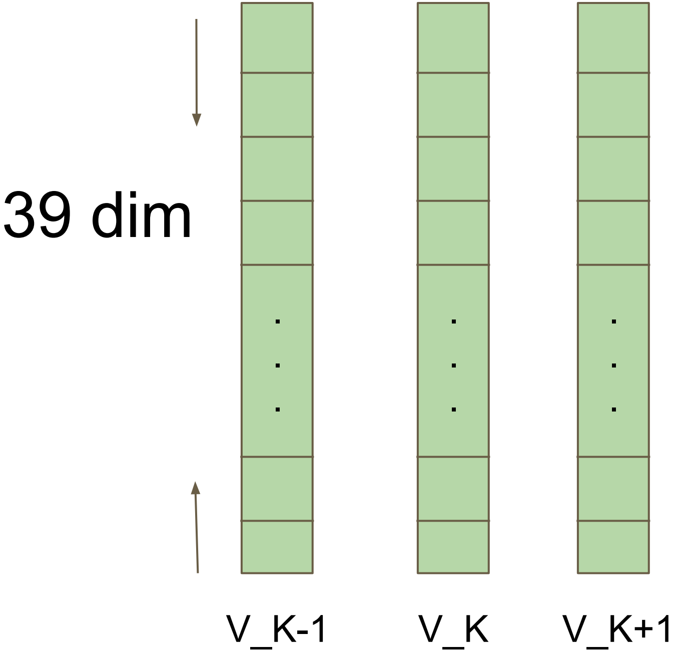
[V_k-1, V_k, V_k+1]
Frame_k

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

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

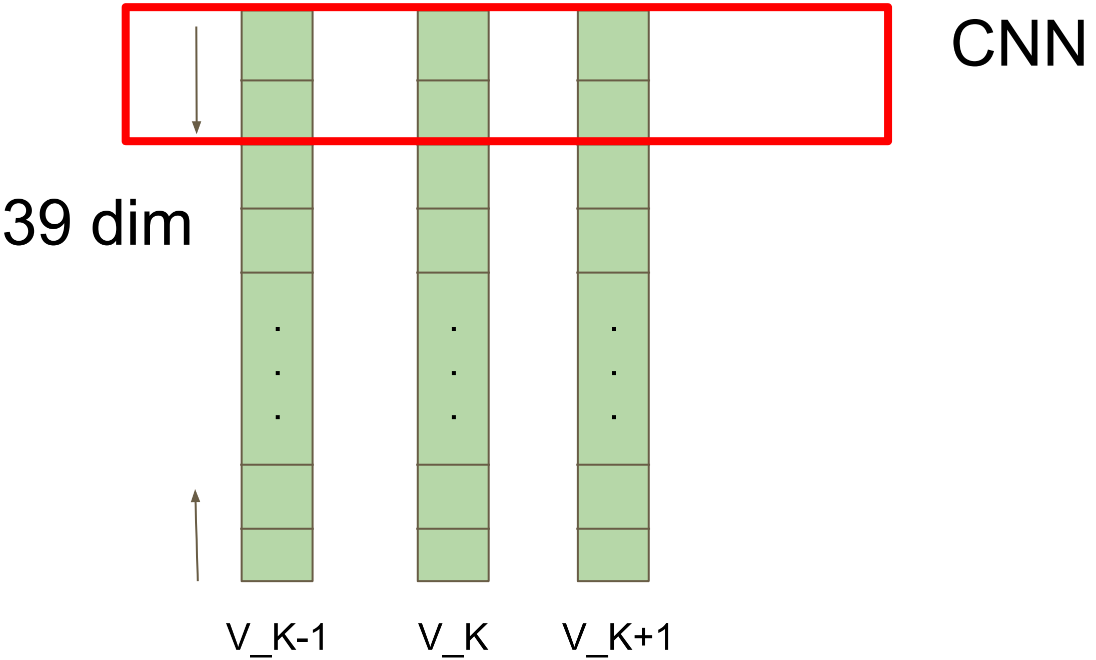
CNN on acoustic features

Take feature MFCC for example:



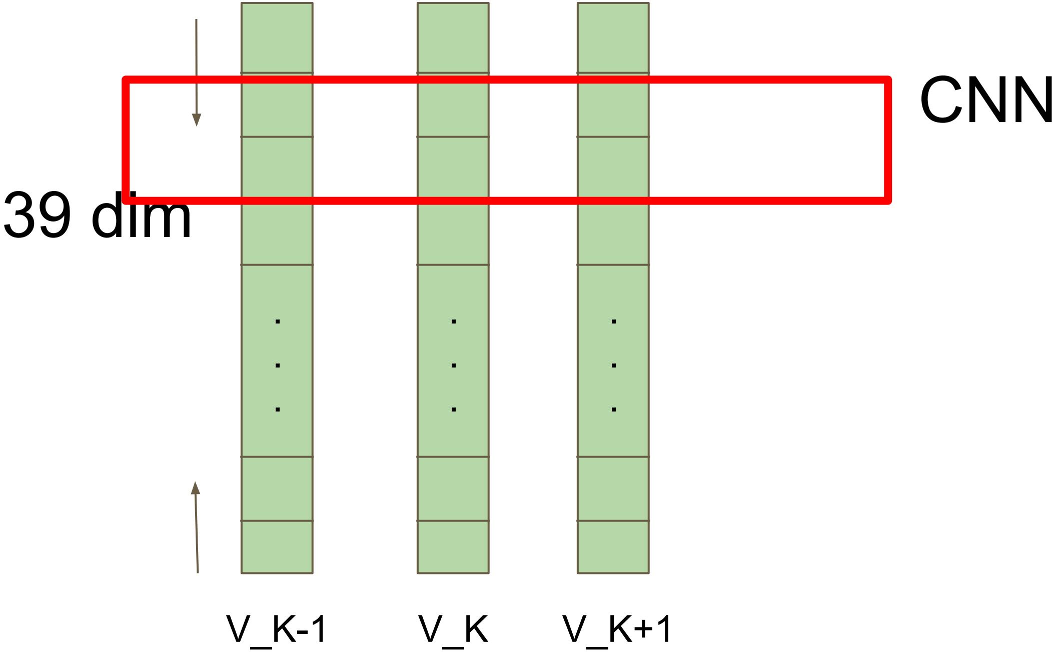
CNN on acoustic features

Take feature MFCC for example:



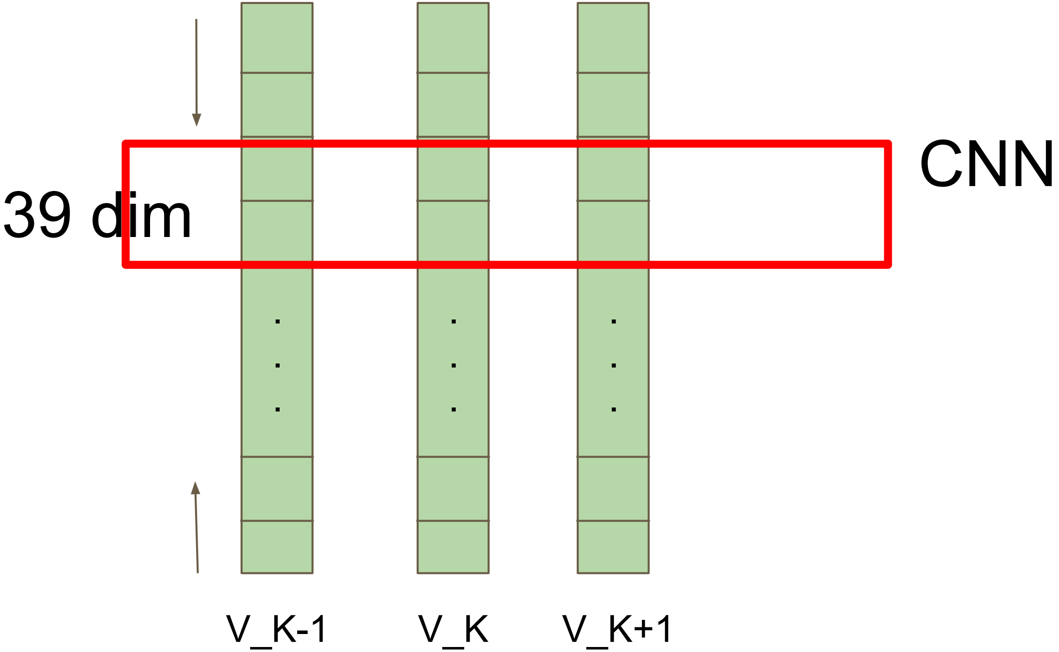
CNN on acoustic features

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

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

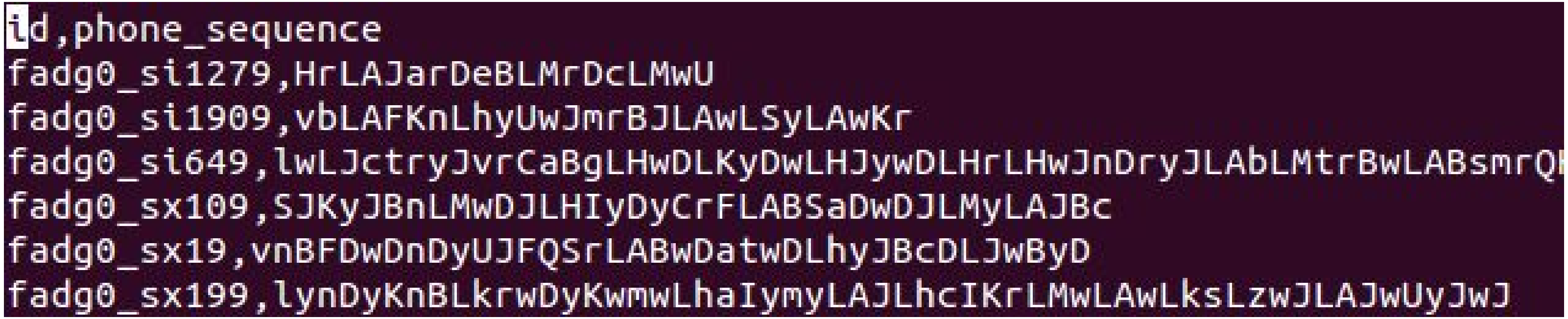
FAIL

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
    - 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 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:

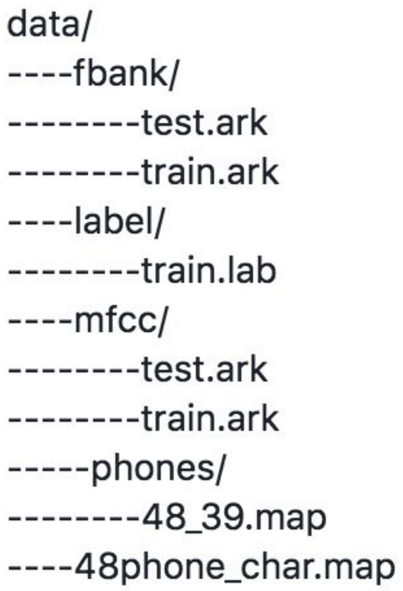
Dataset可以從Kaggle上下載。

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！

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)