

# Homework 2 report

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## Enviroment

os: Archlinux

compiler: gcc version 8.3.0 (GCC)

## Baseline

Number of states: 5

Gaussian mixtures: 2

iterations: 3

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/dsp_hw2/result
[kai@asus-ux410 result]$ cat accuracy
===== HTK Results Analysis =====
Date: Fri May  3 11:38:46 2019
Ref : labels/answer.mlf
Rec : result/result.mlf
----- Overall Results -----
SENT: %Correct=38.54 [H=185, S=295, N=480]
WORD: %Corr=96.61, Acc=74.34 [H=1679, D=13, S=46, I=387, N=1738]
=====
[kai@asus-ux410 result]$
```

## Best Accuracy

Number of states: 15

Gaussian mixtures: 12

iterations: 30

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...
[kai@asus-ux410 result]$ cat accuracy
===== HTK Results Analysis =====
Date: Fri May  3 15:23:25 2019
Ref : labels/answer.mlf
Rec : result/result.mlf
----- Overall Results -----
SENT: %Correct=91.67 [H=440, S=40, N=480]
WORD: %Corr=97.41, Acc=97.35 [H=1693, D=34, S=11, I=1, N=1738]
=====
[kai@asus-ux410 result]$
```

## Discoveries

Test 1: increase iterations(Number of state: 5, Gaussian mixtures: 2)

1. iterations: 10

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 11:56:01 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=46.04 [H=221, S=259, N=480]  
WORD: %Corr=96.66, Acc=77.68 [H=1680, D=17, S=41, I=330, N=1738]  
=====
```

2. iteration: 20

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 12:02:40 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=42.71 [H=205, S=275, N=480]  
WORD: %Corr=96.78, Acc=76.18 [H=1682, D=13, S=43, I=358, N=1738]  
=====
```

3. iteration: 30

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 12:07:16 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=43.75 [H=210, S=270, N=480]  
WORD: %Corr=96.89, Acc=77.16 [H=1684, D=11, S=43, I=343, N=1738]  
=====
```

可以發現只改變若 iterations，accuracy 增加的幅度有限，影響幅度很小，到 iterations=10 的時候大概就已經收斂，若在繼續調高 iterations，accuracy 甚至會下降。

Test 2: increase Gaussian mixtures(number of state: 5, iteration: 15)

1. Gaussian mixtures: 2

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 12:20:26 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=43.33 [H=208, S=272, N=480]  
WORD: %Corr=96.72, Acc=76.12 [H=1681, D=16, S=41, I=358, N=1738]  
=====
```

2. Gaussian mixtures: 4

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 12:17:40 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=53.96 [H=259, S=221, N=480]  
WORD: %Corr=97.35, Acc=82.62 [H=1692, D=15, S=31, I=256, N=1738]  
=====
```

3. Gaussian mixtures: 6

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 12:24:40 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=58.96 [H=283, S=197, N=480]  
WORD: %Corr=97.93, Acc=85.33 [H=1702, D=13, S=23, I=219, N=1738]  
=====
```

4. Gaussian mixtures: 8

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 12:28:01 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=59.17 [H=284, S=196, N=480]  
WORD: %Corr=97.93, Acc=85.44 [H=1702, D=10, S=26, I=217, N=1738]  
=====
```

5. Gaussian mixtures: 10

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 12:31:33 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=62.50 [H=300, S=180, N=480]  
WORD: %Corr=97.70, Acc=87.05 [H=1698, D=16, S=24, I=185, N=1738]  
=====
```

6. Gaussian mixtures: 12

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 14:01:34 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=61.04 [H=293, S=187, N=480]  
WORD: %Corr=97.53, Acc=86.19 [H=1695, D=15, S=28, I=197, N=1738]  
=====
```

7. Gaussian mixtures: 12, iterations: 30

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 15:05:15 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=63.96 [H=307, S=173, N=480]  
WORD: %Corr=97.87, Acc=87.63 [H=1701, D=15, S=22, I=178, N=1738]  
=====
```

可以發現隨著 Gaussian mixtures 提昇，accuracy 會逐漸上升，但上升幅度也有限，到不了規定的 0.95，且若我們不改變 iterations 時，過高的 Gaussian mixtures 可能會讓 accuracy 降低，推測是計算量更大，使得 model 並沒有達到收斂，需要再去調高 iterations，才能達到收斂。

Test 3: increase number of state(Gaussian mixtures: 4, iteration: 15)

1. Number of state: 5

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 12:17:40 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=53.96 [H=259, S=221, N=480]  
WORD: %Corr=97.35, Acc=82.62 [H=1692, D=15, S=31, I=256, N=1738]  
=====
```

2. Number of state: 7

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May 3 14:19:50 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=75.42 [H=362, S=118, N=480]  
WORD: %Corr=97.24, Acc=91.54 [H=1690, D=20, S=28, I=99, N=1738]  
=====
```

3. Number of state: 9

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...
[kai@asus-ux410 result]$ cat accuracy
===== HTK Results Analysis =====
Date: Fri May  3 14:23:29 2019
Ref : labels/answer.mlf
Rec : result/result.mlf
----- Overall Results -----
SENT: %Correct=83.75 [H=402, S=78, N=480]
WORD: %Corr=97.58, Acc=94.59 [H=1696, D=18, S=24, I=52, N=1738]
=====
[kai@asus-ux410 result]$
```

4. Number of state: 11

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...
[kai@asus-ux410 result]$ cat accuracy
===== HTK Results Analysis =====
Date: Fri May  3 14:38:21 2019
Ref : labels/answer.mlf
Rec : result/result.mlf
----- Overall Results -----
SENT: %Correct=88.33 [H=424, S=56, N=480]
WORD: %Corr=97.53, Acc=96.32 [H=1695, D=25, S=18, I=21, N=1738]
=====
[kai@asus-ux410 result]$
```

5. Number of state: 13

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...
[kai@asus-ux410 result]$ cat accuracy
===== HTK Results Analysis =====
Date: Fri May  3 14:42:56 2019
Ref : labels/answer.mlf
Rec : result/result.mlf
----- Overall Results -----
SENT: %Correct=90.62 [H=435, S=45, N=480]
WORD: %Corr=97.58, Acc=97.07 [H=1696, D=30, S=12, I=9, N=1738]
=====
[kai@asus-ux410 result]$
```

6. Number of state: 15

```
kai@asus-ux410:~/Downloads/dsp_hw2-1/ds...  
[kai@asus-ux410 result]$ cat accuracy  
===== HTK Results Analysis =====  
Date: Fri May  3 14:47:30 2019  
Ref : labels/answer.mlf  
Rec : result/result.mlf  
----- Overall Results -----  
SENT: %Correct=89.38 [H=429, S=51, N=480]  
WORD: %Corr=96.89, Acc=96.49 [H=1684, D=38, S=16, I=7, N=1738]  
=====
```

可以發現調整 Number of state 上升幅度比起前面兩個大很多，且不需要刻意去增加 iterations，就能使 accuracy 上升，因此可以推測 train state 的速度比 train gaussian 的速度要來的快達到收斂。

## conclusion

調整 Number of state 所達到的效益最大，可以使得 accuracy 增加最多，接下來則是調整 Gaussian mixtures，但因為 Gaussian mixtures 越多則越慢達到收斂，故調整到相對的 iterations 才能達到它真正的效益。