Digital Speech Processing HW2-1

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Runtime Environment

System : OS X Mojave
Compiler : NTU CSIE Workstation

The Terms We Need to know in the Accuracy file

- The percentage number of labels correctly recognised is given by

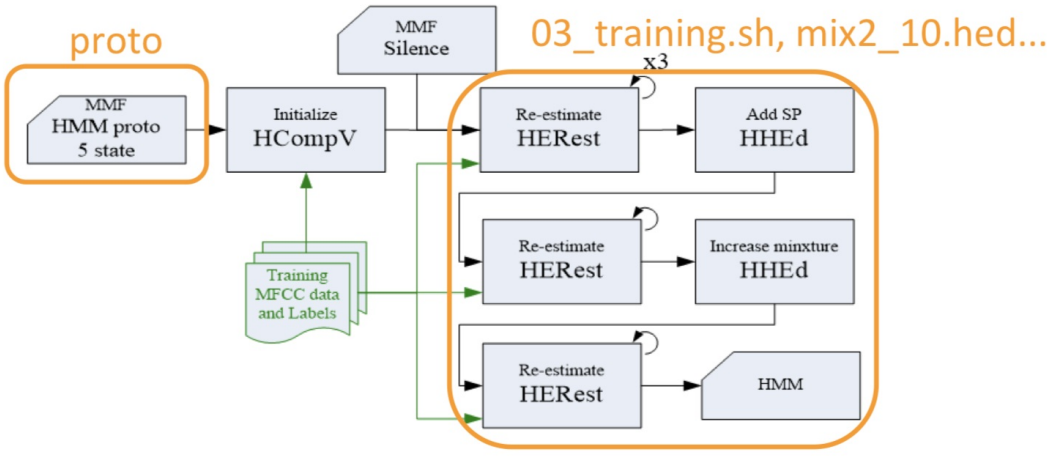
$$\%\text{Correct} = \frac{H}{N} \times 100\%$$

- The accuracy is computed by

$$\text{Accuracy} = \frac{H - I}{N} \times 100\%$$

Modification of Models

I change several things on the homework package.
Basically, oriented to Number of states, Gaussian mixtures, and the iterations.



The baseline :

```
=================== HTK Results Analysis ==================
  Date: Wed Nov 14 19:10:39 2018
  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]
===========================================================
```

Changing the Number of States

```
lib/proto
```

Change the Number of States to 10

```
=================== HTK Results Analysis ==================
  Date: Wed Nov 14 19:33:20 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=80.83 [H=388, S=92, N=480]
WORD: %Corr=96.61, Acc=93.67 [H=1679, D=26, S=33, I=51, N=1738]
===========================================================
```

Based on the accuracy result above, the %correct changes from 38.54 to 80.83 , the Accuracy also changes from 74.34 to 93.67 while the %corr is still the same , 96.61 .

Change the Number of States to 15

```
=================== HTK Results Analysis ==================
  Date: Wed Nov 14 19:48:56 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=87.50 [H=420, S=60, N=480]
WORD: %Corr=96.26, Acc=95.91 [H=1673, D=41, S=24, I=6, N=1738]
===========================================================
```

The %correct changes from 80.83 to 87.50 and the Accuracy increases from 93.67 to 95.91. However, the %corr decreases from 96.61 to 96.26 .

Change the Number of States to 20

```
=================== HTK Results Analysis ==================
  Date: Wed Nov 14 19:55:59 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=87.50 [H=420, S=60, N=480]
WORD: %Corr=96.26, Acc=95.91 [H=1673, D=41, S=24, I=6, N=1738]
===========================================================
```

Based on the analysis of this new number of states, there is no change happening.

Change the Gaussian Mixtures

Despite of changing the number of gaussian mixtures, I first try to increase the number of gaussian mixtures.

```
lib/mix2_10.hed
```

Increase the Gaussian Mixtures to 5

```
====================== HTK Results Analysis =======================
  Date: Wed Nov 14 20:05:45 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=86.88 [H=417, S=63, N=480]
WORD: %Corr=96.14, Acc=95.68 [H=1671, D=43, S=24, I=8, N=1738]
==================================================================
```

%correct, %corr, Accuraccy are decreasing .

Increase the Gaussian Mixtures to 10

```
====================== HTK Results Analysis =======================
  Date: Wed Nov 14 20:08:52 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=89.17 [H=428, S=52, N=480]
WORD: %Corr=96.78, Acc=96.43 [H=1682, D=38, S=18, I=6, N=1738]
==================================================================
```

The %correct is increasing from 86.88 to 89.17 and the Accuraccy is also increasing from 95.68 to 96.43 .

Increase the Gaussian Mixtures to 15

```
====================== HTK Results Analysis =======================
  Date: Wed Nov 14 20:14:55 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=88.75 [H=426, S=54, N=480]
WORD: %Corr=96.72, Acc=96.32 [H=1681, D=39, S=18, I=7, N=1738]
==================================================================
```

%correct, %corr, Accuraccy are decreasing .

Whereas,

When changing the destination number of states to mixture to [2-14]

```
====================== HTK Results Analysis =======================
  Date: Wed Nov 14 20:28:14 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=91.25 [H=438, S=42, N=480]
WORD: %Corr=97.35, Acc=97.18 [H=1692, D=34, S=12, I=3, N=1738]
==================================================================
```

The 3 components here are all getting better.

Increase the Gaussian Mixtures to 20 and change the .state[2-14]

```
====================== HTK Results Analysis =======================
  Date: Wed Nov 14 20:22:50 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=91.88 [H=441, S=39, N=480]
WORD: %Corr=97.53, Acc=97.41 [H=1695, D=34, S=9, I=2, N=1738]
==================================================================
```

Finally, we get %correct > 90%. The %corr and Accuraccy are also getting better now.

Change the Number of Iterations to train the models

```
03_training.sh
```

Change the number of iterations to 20

```
====================== HTK Results Analysis =======================
  Date: Wed Nov 14 20:38:37 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=94.38 [H=453, S=27, N=480]
WORD: %Corr=98.33, Acc=98.22 [H=1709, D=25, S=4, I=2, N=1738]
==================================================================
```

Change the number of iterations to 30

```
====================== HTK Results Analysis =======================
  Date: Wed Nov 14 20:47:26 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=94.38 [H=453, S=27, N=480]
WORD: %Corr=98.27, Acc=98.22 [H=1708, D=23, S=7, I=1, N=1738]
==================================================================
```

Change the number of iterations to 40

```
====================== HTK Results Analysis =======================
  Date: Wed Nov 14 20:56:47 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=94.58 [H=454, S=26, N=480]
WORD: %Corr=98.39, Acc=98.33 [H=1710, D=24, S=4, I=1, N=1738]
==================================================================
```

Change the number of iterations to 50

```
====================== HTK Results Analysis =======================
  Date: Wed Nov 14 21:08:59 2018
  Ref : labels/answer.mlf
  Rec : result/result.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=94.58 [H=454, S=26, N=480]
WORD: %Corr=98.39, Acc=98.33 [H=1710, D=24, S=4, I=1, N=1738]
====================================================================
```

Realization

There is some time when you change the number of states, there are no changes happening.

There is also some time when you change the number of gaussian mixtures to be higher, no changes happens. However, when you continue to change the number much higher, there is a change.

Notice that increasing the number of states / number of gaussian mixtures / number of iterations will not always produce a better Accuraccy.

Conclusion

I have changed several things to increase the Accuraccy.

1. Number of States = 15
2. Number of Gaussian Mixtures =

```
MU 2 {liN.state[2-14].mix}
MU 2 {#i.state[2-14].mix}
MU 2 {#er.state[2-14].mix}
MU 2 {san.state[2-14].mix}
MU 2 {sy.state[2-14].mix}
MU 2 {#u.state[2-14].mix}
MU 2 {liou.state[2-14].mix}
MU 2 {qi.state[2-14].mix}
MU 2 {ba.state[2-14].mix}
MU 2 {jiou.state[2-14].mix}
MU 3 {sil.state[2-4].mix}

MU +15 {liN.state[2-14].mix}
MU +15 {#i.state[2-14].mix}
MU +15 {#er.state[2-14].mix}
MU +15 {san.state[2-14].mix}
MU +15 {sy.state[2-14].mix}
MU +15 {#u.state[2-14].mix}
MU +15 {liou.state[2-14].mix}
MU +15 {qi.state[2-14].mix}
MU +15 {ba.state[2-14].mix}
MU +15 {jiou.state[2-14].mix}
MU +15 {sil.state[2-4].mix}
```

3. Number of Iterations = 50