SGN-4507 Speech Recognition Laboratory

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1. Creating the dictionary
a) the file *dictionary*:

```
!ENTER       sil
!EXIT        sil
KAHDEKSAN    kahdeksan
KAKSI        kaksi
KOLME        kolme
KUUSI        kuusi
NELJA        nelja
NOLLA        nolla
SEITSEMAN    seitseman
VIISI        viisi
YHDEKSAN     yhdeksan
YKSI         yksi
```

b) the file *model_list*:

```
sil
kahdeksan
kaksi
kolme
kuusi
nelja
nolla
seitseman
viisi
yhdeksan
yksi
```

2. Script files
a) the file *Create MLF.py* – a script creating MLFs from labels.txt file:

```
import os

# Constants declarations
PATH = "/home/latusek/Speech Recognition Laboratory/"
IN_FILE = os.path.join(PATH, "labels.txt")
MLF_TRAIN_FILE = os.path.join(PATH, "train.mlf")
MLF_TEST_FILE = os.path.join(PATH, "test.mlf")
SCP_TRAIN_FILE = os.path.join(PATH, "train.scp")
SCP_TEST_FILE = os.path.join(PATH, "test.scp")


digits = {"nolla": "NOLLA",
     "yksi": "YKSI",
     "kaksi": "KAKSI",
```

```
      "kolme": "KOLME",
      "neljä": "NELJA",
      "viisi": "VIISI",
      "kuusi": "KUUSI",
      "seitsemän": "SEITSEMAN",
      "kahdeksan": "KAHDEKSAN",
      "yhdeksän": "YHDEKSAN"}

# Opening files
inFile = open(IN_FILE, "rb")
mlfTrainFile = open(MLF_TRAIN_FILE, "wb")
mlfTestFile = open(MLF_TEST_FILE, "wb")
scpTrainFile = open(SCP_TRAIN_FILE, "wb")
scpTestFile = open(SCP_TEST_FILE, "wb")

# Generating training files
mlfTrainFile.write("#!MLF!#\n")
for i in range(0, 2500):
      entry = inFile.readline()
      words = entry.split(' ')
      file = words[0]
      file = file.replace('/share/', '/opt/local/')
      digit = words[2].strip('\r\n')

      mlfTrainFile.write('"')
      mlfTrainFile.write(file)
      mlfTrainFile.write('"\n')
      mlfTrainFile.write(digits.get(digit))
      mlfTrainFile.write("\n.\n")

      scpTrainFile.write(file.replace('FIAFIO',
      'MFC_Z').replace('.fio', '.mfc'))
      scpTrainFile.write("\n")

# Generating test files
mlfTestFile.write("#!MLF!#\n")
for i in range(2500, 3000):
      entry = inFile.readline()
      words = entry.split(' ')
      file = words[0]
      file = file.replace('/share/', '/opt/local/')
      digit = words[2].strip('\r\n')

      mlfTestFile.write('"')
      mlfTestFile.write(file)
      mlfTestFile.write('"\n')
      mlfTestFile.write(digits.get(digit))
      mlfTestFile.write("\n.\n")

      scpTestFile.write(file.replace('FIAFIO',
      'MFC_Z').replace('.fio', '.mfc'))
      scpTestFile.write("\n")

# Closing files

inFile.close()
```

```
mlfTrainFile.close()
mlfTestFile.close()
scpTrainFile.close()
scpTestFile.close()
```

b) HLEd command line for creating the phoneme-level training MLF:

```
HLEd -l '*' -d dict -i train_phones0.mlf mkphones0.led
train.mlf
HLEd -l '*' -d dict -i test_phones0.mlf mkphones0.led
test.mlf
```

3. Feature extraction
a) configuration file for HCopy command:

```
# Coding parameters
TARGETKIND = MFCC_0_Z
TARGETRATE = 100000.0
SAVECOMPRESSED = F
SAVEWITHCRC = F
WINDOWSIZE = 250000.0
USEHAMMING = T
PREEMCOEF = 0.97
NUMCHANS = 26
CEPLIFTER = 22
NUMCEPS = 12
ENORMALISE = T
SOURCEFORMAT = WAVE
```

b) HCopy command:

```
HCopy -T 1 -C config -S feature_extraction.scp
```

4. Initialization of the HMMs
a) *proto* file:

```
~o <VecSize> 39 <MFCC_0_D_A_Z>
~h "proto"
<BeginHMM>
  <NumStates> 14
  <State> 2
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 3
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
```

```
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 4
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 5
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 6
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 7
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 8
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 9
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
```

```
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 10
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 11
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 12
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 13
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <TransP> 14
    0.0 1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    0.0 0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    0.0 0.0 0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    0.0 0.0 0.0 0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    0.0 0.0 0.0 0.0 0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    0.0 0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.0 0.0 0.0 0.0 0.0 0.0
    0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.0 0.0 0.0 0.0 0.0
    0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.0 0.0 0.0 0.0
    0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.0 0.0 0.0
    0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.0 0.0
    0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.5 0.5 0.0
    0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.5 0.5
    0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
<EndHMM>
```

b) *proto_sil* file:

```
~o <VecSize> 39 <MFCC_0_D_A_Z>
~h "proto_sil"
<BeginHMM>
  <NumStates> 5
  <State> 2
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 3
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <State> 4
    <Mean> 39
      0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
    <Variance> 39
      1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  <TransP> 5
    0.0 1.0 0.0 0.0 0.0
    0.0 0.5 0.5 0.0 0.0
    0.0 0.0 0.5 0.5 0.0
    0.0 0.0 0.0 0.5 0.5
    0.0 0.0 0.0 0.0 0.0
<EndHMM>
```

c) HCompV commands:

```
HCompV -C config_hcompv -f 0.01 -m -S train.scp -M hmm0 proto
HCompV -C config_hcompv -f 0.01 -m -S train.scp -M hmm0 proto_sil
```

5. Training and Evaluation of the HMMs

a) The full HERest, HVite and HResults-commands for the first iteration:

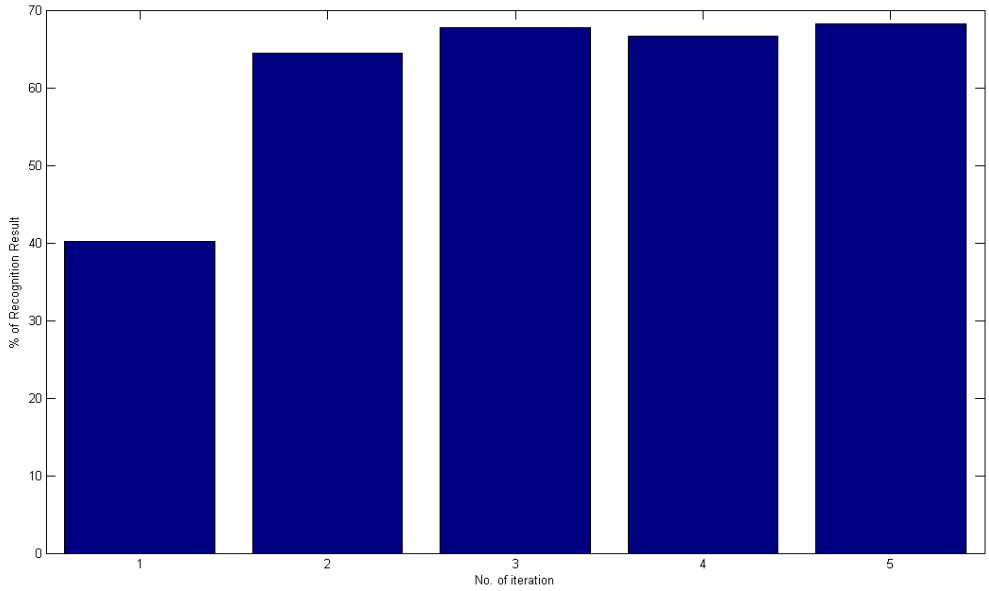
```
HERest -C config_hcompv -I train_phones0.mlf -t 250.0 150.0
1000.0 -S train.scp -H hmm0/macros -H hmm0/hmmdefs -M hmm1
model_list

HVite -H hmm1/macros -H hmm1/hmmdefs -S test.scp -l '*' -i
recout1.mlf -w wdnet -p 0.0 -s 5.0 dict model_list -C
```

```
config_hcompv

HResults -X rec -I recout1.mlf model_list test.mlf
```

b) The recognition results (given by HResults) after each iteration




```
====================== HTK Results Analysis =======================
Date: Tue May 19 19:08:51 2009
Ref : recout1.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=40.20 [H=201, S=299, N=500]
WORD: %Corr=40.20, Acc=40.20 [H=201, D=0, S=299, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:09:18 2009
Ref : recout2.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=64.40 [H=322, S=178, N=500]
WORD: %Corr=64.40, Acc=64.40 [H=322, D=0, S=178, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:09:43 2009
Ref : recout3.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=67.80 [H=339, S=161, N=500]
WORD: %Corr=67.80, Acc=67.80 [H=339, D=0, S=161, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:10:09 2009
Ref : recout4.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=66.60 [H=333, S=167, N=500]
WORD: %Corr=66.60, Acc=66.60 [H=333, D=0, S=167, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:10:33 2009
Ref : recout5.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=68.20 [H=341, S=159, N=500]
WORD: %Corr=68.20, Acc=68.20 [H=341, D=0, S=159, I=0, N=500]
===================================================================
```

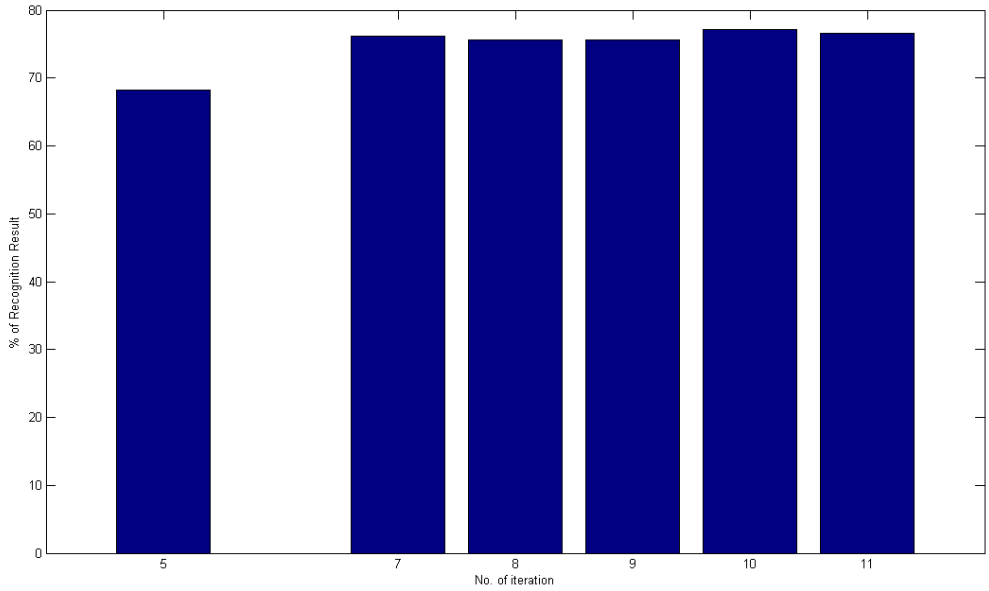
6. Fixing the Silence Model
a) HHEd command:

```
HHEd -H hmm5/macros -H hmm5/hmmdefs -M hmm6 sil.hed
model_list
```

b) *sil.hed* file:

```
AT 2 4 0.2 {sil.transP}
AT 4 2 0.2 {sil.transP}
TI silst {sil.state[3]}
```

c) The recognition results after each iteration




```
====================== HTK Results Analysis =======================
Date: Tue May 19 19:34:51 2009
Ref : recout7.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=76.20 [H=381, S=119, N=500]
WORD: %Corr=76.20, Acc=76.20 [H=381, D=0, S=119, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:35:16 2009
Ref : recout8.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=75.60 [H=378, S=122, N=500]
WORD: %Corr=75.60, Acc=75.60 [H=378, D=0, S=122, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:35:40 2009
Ref : recout9.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=75.60 [H=378, S=122, N=500]
WORD: %Corr=75.60, Acc=75.60 [H=378, D=0, S=122, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:36:06 2009
Ref : recout10.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=77.20 [H=386, S=114, N=500]
WORD: %Corr=77.20, Acc=77.20 [H=386, D=0, S=114, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:36:31 2009
Ref : recout11.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=76.60 [H=383, S=117, N=500]
WORD: %Corr=76.60, Acc=76.60 [H=383, D=0, S=117, I=0, N=500]
===================================================================
```

Adding Mixtures
a) HHEd command:

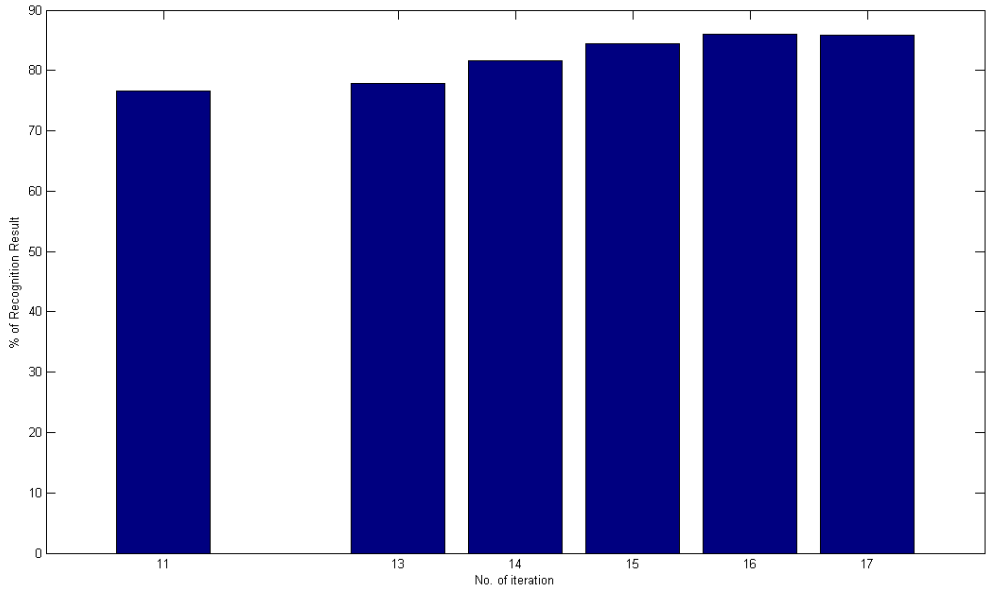
```
HHEd -H hmm11/hmmdefs -H hmm11/macros -M hmm12 cmds.hed
model_list
```

b) *cmds.hed* file:

Adding 3 mixtures:

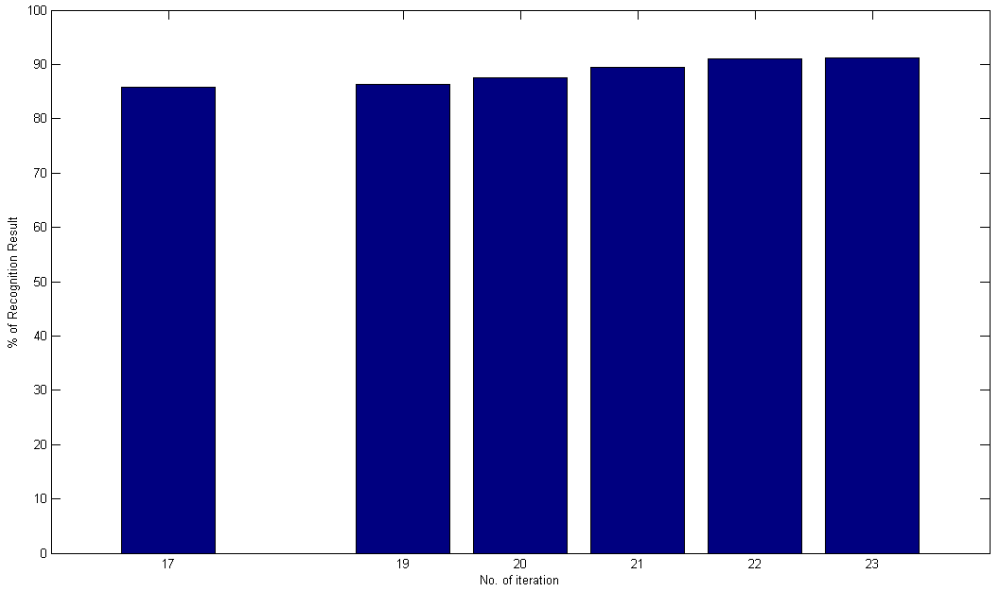
```
MU 3 {*.state[2-13].mix}
```

d) The recognition results after each iteration with 3 mixtures in each HMM state



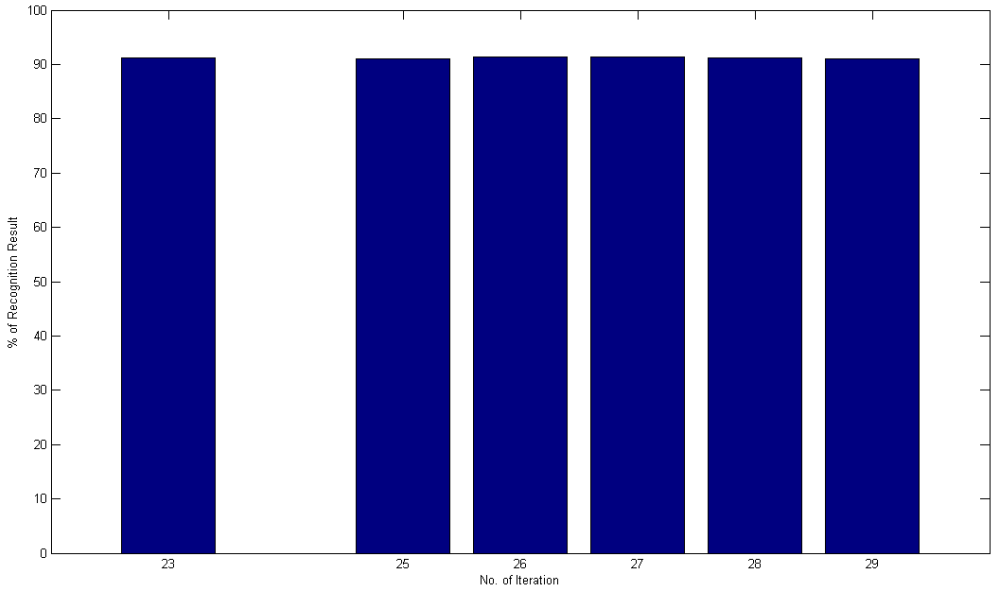

```
====================== HTK Results Analysis =======================
Date: Tue May 19 19:37:27 2009
Ref : recout13.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=77.80 [H=389, S=111, N=500]
WORD: %Corr=77.80, Acc=77.80 [H=389, D=0, S=111, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:38:21 2009
Ref : recout14.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=81.60 [H=408, S=92, N=500]
WORD: %Corr=81.60, Acc=81.60 [H=408, D=0, S=92, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:39:15 2009
Ref : recout15.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=84.40 [H=422, S=78, N=500]
WORD: %Corr=84.40, Acc=84.40 [H=422, D=0, S=78, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:40:10 2009
Ref : recout16.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=86.00 [H=430, S=70, N=500]
WORD: %Corr=86.00, Acc=86.00 [H=430, D=0, S=70, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:41:05 2009
Ref : recout17.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=85.80 [H=429, S=71, N=500]
WORD: %Corr=85.80, Acc=85.80 [H=429, D=0, S=71, I=0, N=500]
===================================================================
```

e) The recognition results after each iteration with 5 mixtures in each HMM state




```
====================== HTK Results Analysis =======================
Date: Tue May 19 19:42:26 2009
Ref : recout19.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=86.40 [H=432, S=68, N=500]
WORD: %Corr=86.40, Acc=86.40 [H=432, D=0, S=68, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:43:43 2009
Ref : recout20.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=87.60 [H=438, S=62, N=500]
WORD: %Corr=87.60, Acc=87.60 [H=438, D=0, S=62, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:45:00 2009
Ref : recout21.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=89.40 [H=447, S=53, N=500]
WORD: %Corr=89.40, Acc=89.40 [H=447, D=0, S=53, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:46:17 2009
Ref : recout22.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=91.00 [H=455, S=45, N=500]
WORD: %Corr=91.00, Acc=91.00 [H=455, D=0, S=45, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:47:36 2009
Ref : recout23.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=91.20 [H=456, S=44, N=500]
WORD: %Corr=91.20, Acc=91.20 [H=456, D=0, S=44, I=0, N=500]
===================================================================
```

f) The recognition results after each iteration with 7 mixtures in each HMM state




```
====================== HTK Results Analysis =======================
Date: Tue May 19 19:49:18 2009
Ref : recout25.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=91.00 [H=455, S=45, N=500]
WORD: %Corr=91.00, Acc=91.00 [H=455, D=0, S=45, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:50:55 2009
Ref : recout26.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=91.40 [H=457, S=43, N=500]
WORD: %Corr=91.40, Acc=91.40 [H=457, D=0, S=43, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:52:33 2009
Ref : recout27.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=91.40 [H=457, S=43, N=500]
WORD: %Corr=91.40, Acc=91.40 [H=457, D=0, S=43, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:54:09 2009
Ref : recout28.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=91.20 [H=456, S=44, N=500]
WORD: %Corr=91.20, Acc=91.20 [H=456, D=0, S=44, I=0, N=500]
===================================================================
====================== HTK Results Analysis =======================
Date: Tue May 19 19:55:46 2009
Ref : recout29.mlf
Rec : test.mlf
------------------------ Overall Results --------------------------
SENT: %Correct=91.00 [H=455, S=45, N=500]
WORD: %Corr=91.00, Acc=91.00 [H=455, D=0, S=45, I=0, N=500]
===================================================================
```