VIETNAM NATIONAL UNIVERSITY
UNIVERSITY OF ENGINEERING AND TECHNOLOGY

SPEECH PROCESSING

HMM MODEL TRAINING REPORT

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List word to recognition:

- *"tôi"*
- *"dịch"*
- *"theo"*
- *"người"*
- *"bệnh_nhân"*

Dataset

	toi	dich	nguoi	theo	benh_nhan
Train	36	70	131	82	132
Test	50	50	50	50	50

Model

For each word, we build a model for it based on the Gaussian Mixture Model HMM model and the number of its phonemes. In details:

```python
dict_components = {
    # toi |t|~|o|~|i||
    "toi": 9,
    # dich |d|~|i|~|ch|
    "dich": 9,
    # nguoi |ng|~|uo|~|i|
    "nguoi": 9,
    # theo |th|~|e|~|o|
    "theo": 9,
    # benh_nhan |b|~|e|~|nh|~|silent|~|nh|~|a|~|n|
    "benh_nhan": 18,
}

startprob = np.zeros(n)
startprob[0] = 1.0
transmat=np.diag(np.full(n,1))


hmm = hmmlearn.hmm.GMMHMM(
    n_components=n,
    n_mix = 4, random_state=10, n_iter=500, verbose=True,
    params='mctw', init_params='mct',
    startprob_prior=startprob,
    transmat_prior=transmat,
)
```

1. *"tôi"*:

+ Trained metrics:

```
hmm.startprob_ = ([0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111])
hmm.transmat_ = ([
    [0.863 0.    0.014 0.031 0.014 0.    0.    0.077 0.   ]
    [0.    0.679 0.    0.    0.07  0.057 0.174 0.021 0.   ]
    [0.028 0.    0.822 0.027 0.    0.    0.    0.123 0.   ]
```

```
       [0.031 0.    0.    0.884 0.    0.    0.    0.085 0.   ]
       [0.038 0.016 0.021 0.005 0.893 0.    0.    0.027 0.   ]
       [0.    0.    0.    0.    0.    0.852 0.085 0.    0.062]
       [0.    0.    0.    0.    0.013 0.    0.808 0.    0.178]
       [0.009 0.289 0.028 0.019 0.    0.    0.    0.655 0.   ]
       [0.022 0.072 0.017 0.    0.039 0.    0.    0.    0.851]
     ])
```

2. *"dịch":*

+ Trained metrics

```
hmm.startprob_ = ([0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111])
hmm.transmat_ = ([
    [0.839 0.    0.007 0.029 0.005 0.097 0.    0.    0.022]
    [0.    0.784 0.    0.    0.216 0.    0.    0.    0.   ]
    [0.    0.17  0.635 0.    0.146 0.    0.    0.049 0.   ]
    [0.    0.011 0.017 0.761 0.    0.006 0.    0.    0.205]
    [0.224 0.    0.    0.057 0.678 0.04  0.    0.    0.   ]
    [0.03  0.    0.006 0.016 0.009 0.845 0.094 0.    0.   ]
    [0.012 0.    0.052 0.063 0.012 0.017 0.845 0.    0.   ]
    [0.    0.    0.    0.    0.16  0.    0.    0.84  0.   ]
    [0.    0.022 0.222 0.    0.    0.    0.    0.    0.756]
  ])
```

3. *"theo":*

+ Trained metrics

```
hmm.startprob_ = ([0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111])
hmm.transmat_ = ([
      [[0.784 0.069 0.    0.    0.    0.147 0.    0.    0.   ]
       [0.    0.828 0.016 0.004 0.    0.011 0.036 0.076 0.029]
       [0.    0.    0.832 0.08  0.    0.    0.024 0.032 0.032]
       [0.078 0.    0.    0.788 0.131 0.    0.003 0.    0.   ]
       [0.185 0.    0.    0.    0.815 0.    0.    0.    0.   ]
       [0.    0.082 0.005 0.    0.    0.858 0.021 0.009 0.024]
       [0.    0.    0.003 0.191 0.    0.    0.806 0.    0.   ]
       [0.    0.    0.032 0.    0.    0.    0.068 0.883 0.016]
       [0.005 0.    0.006 0.049 0.    0.    0.049 0.026 0.865]]
     ])
```

4. *"người":*

+ Trained metrics

```
hmm.startprob_ = ([0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111])
hmm.transmat_ = ([
       [0.77  0.002 0.    0.    0.    0.228 0.    0.    0.   ]
       [0.159 0.831 0.    0.    0.002 0.    0.    0.007 0.   ]
       [0.    0.    0.749 0.212 0.    0.    0.    0.039 0.   ]
       [0.016 0.053 0.    0.736 0.146 0.    0.    0.049 0.   ]
       [0.045 0.053 0.    0.    0.792 0.    0.    0.049 0.061]
       [0.    0.    0.012 0.    0.    0.668 0.32  0.    0.   ]
       [0.006 0.    0.335 0.013 0.    0.    0.646 0.    0.   ]
       [0.095 0.069 0.    0.    0.004 0.044 0.    0.788 0.   ]
       [0.015 0.087 0.    0.    0.    0.016 0.    0.    0.882]
     ])
```

5. *"bệnh_nhân":*

+ Trained metrics

```
hmm.startprob_  = ([0.056 0.056 0.056 0.056 0.056 0.056 0.056 0.056 0.056 0.056 0.056
0.056 0.056 0.056 0.056 0.056 0.056 0.056])
hmm.transmat_  = ([
  [0.557 0.    0.    0.    0.    0.    0.    0.    0.09  0.098 0.    0.    0.    0.    0.255 0.    0.    0.
]
  [0.    0.753 0.    0.    0.008 0.038 0.    0.005 0.    0.    0.015 0.    0.    0.107 0.    0.035 0.
0.039]
  [0.    0.    0.714 0.    0.    0.    0.    0.058 0.    0.012 0.    0.019 0.    0.    0.036 0.    0.16  0.
]
  [0.    0.    0.    0.626 0.    0.    0.    0.    0.    0.018 0.    0.    0.309 0.    0.046 0.    0.    0.
]
  [0.    0.    0.    0.131 0.793 0.076 0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.
]
  [0.    0.    0.    0.06  0.    0.768 0.    0.    0.    0.    0.043 0.    0.057 0.058 0.    0.    0.
0.014]
  [0.317 0.    0.    0.    0.    0.    0.683 0.    0.    0.    0.    0.    0.    0.    0.    0.    0.    0.
]
  [0.    0.089 0.    0.002 0.    0.017 0.    0.744 0.    0.    0.009 0.    0.    0.    0.    0.093 0.012
0.034]
  [0.    0.    0.122 0.    0.    0.    0.    0.    0.588 0.    0.    0.291 0.    0.    0.    0.    0.    0.
]
  [0.    0.    0.075 0.    0.    0.    0.    0.082 0.009 0.622 0.    0.    0.    0.    0.212 0.    0.    0.
]
  [0.    0.    0.    0.019 0.031 0.016 0.    0.    0.    0.    0.857 0.    0.    0.    0.01  0.026 0.
0.041]
  [0.209 0.    0.    0.    0.    0.    0.13  0.    0.    0.11  0.    0.55  0.    0.    0.    0.    0.    0.
]
  [0.106 0.    0.    0.    0.    0.    0.007 0.    0.    0.256 0.    0.    0.631 0.    0.    0.    0.    0.
]
  [0.    0.    0.075 0.    0.    0.011 0.    0.    0.328 0.    0.    0.068 0.    0.518 0.    0.    0.    0.
]
  [0.    0.058 0.014 0.002 0.    0.023 0.    0.114 0.    0.004 0.004 0.    0.    0.    0.684 0.005 0.081
0.01 ]
  [0.    0.009 0.    0.022 0.021 0.024 0.    0.    0.    0.    0.009 0.    0.    0.036 0.002 0.794 0.
0.082]
  [0.    0.045 0.    0.    0.    0.014 0.    0.023 0.    0.    0.    0.    0.    0.013 0.    0.046 0.829
0.029]
  [0.009 0.    0.    0.078 0.    0.    0.    0.    0.    0.    0.    0.079 0.167 0.    0.    0.
0.666]
  ])
```

RESULTS

With the test dataset:

Accuracy of HMM models on test dataset
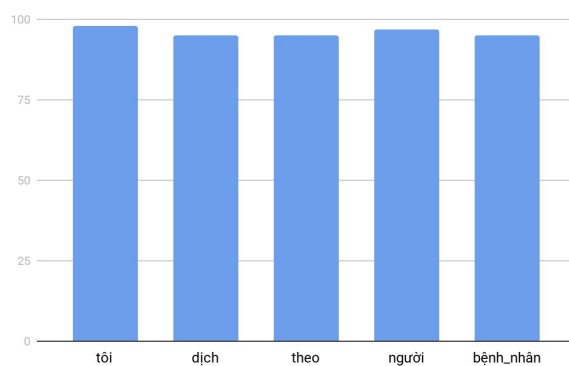
With the recorded dataset:

Accuracy of HMM model on recorded dataset