LF-MMI是个用作区分性训练的好方法，本人最近任务繁重，就直接上我整理的内容

LF-MMI是Dan 在 Povey D, Peddinti V, Galvez D, et al. Purely sequence-trained neural networks for ASR based on lattice-free MMI[J]. Submitted to Interspeech, 2016.
这篇文章提出来的

爱丁堡大学的guest lecturer 对于LF-MMI 的分享

其推荐的2018年Dan的论文：
Flat-Start Single-Stage Discriminatively Trained HMM-Based Models for ASR
https://ieeexplore.ieee.org/abstract/document/8387866

MMI TRAINING

- **Motivation**: Maximum likelihood (ML) is theoretically optimal (even for classification), but only when the model is correct. If the model is incorrecy, then an explicitly discriminative training criterion might be better
- **Example of the deficiencies of maximum likelihood**: Consider the classification problem of slides 9-12. This can be well-modelled using full covariance Gaussians for each class, trained by ML. However the decision boundaries using diagonal covariance Gaussians trained by ML result in classification errors; training the same diagonal covariance Gaussians using MMI results in better decision boundaries with fewer classification errors.
- **MMI training**: As explained in the last lecture MMI involves computing the clamped numerator term and the free denominator term using the forward-backward algorithm to estimate state occupation probabilities. In practice these terms are compute using lattices. Lattice generation is expensive since it involves a recognition run.

LATTICE-FREE MMI

- **Overview**: LF-MMI enables sequence-level HMM state posteriors to be estimated using DNN acoustic model.

- **Key aspects of LF-MMI**:
    - Represent state sequences for numerator and denominator as HCLG WFSTs
    - Parallelise computation on GPU
    - Use a 4-gram phone LM (rather than a word LM) in the denominator
    - Reduced frame rate, simpler context-dependent phone HMM topology (single state)
    - Regularize using multi-task training (simulataneously optimise sequential MMI objective, and frame-wise cross-entropy objective)
- **LF-MMI in practice**: LF-MMI offers based increased accuracy and faster training for HMM/TDNN systems compared to both cross-entropy (framewise) training and lattice-based sequence training.

http://www.inf.ed.ac.uk/teaching/courses/asr/2018-19/asr12-lfmmi.pdf

知乎上不错的解释：

kaldi中的chain model(LFMMI)详解

https://zhuanlan.zhihu.com/p/65557682

不错的解释：

https://www.zhihu.com/question/56805932/answer/181226629

https://zhuanlan.zhihu.com/p/99689543

语音识别系列之区分性训练和LF-MMI：

https://zhuanlan.zhihu.com/p/113715935

JHU的**Desh Raj** 对于两者在kaldi上的运行的解释

On lattice free MMI and Chain models in Kaldi

https://desh2608.github.io/2019-05-21-chain/

无关消息：

LF-MMI 用在dysarthric speech recognition上的文章。。用的数据集是Torgo，感觉emmm：

http://publications.idiap.ch/downloads/papers/2020/Hermann_ICASSP_2020.pdf