Dialectal Chinese Speech Recognition

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Dialects ( ) vs.Accented Putonghua

- Linguistically, the "dialects" are really different languages.
- This project treats *Putonghua* (PTH - Standard Mandarin) spoken by Shanghainese whose native language is *Wu:* **Wu-Dialectal Chinese.**

Dialectal Chinese Speech Recognition

Workshop 2004
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Project Goals

- Overall goal: find methods that show promise for improving recognition of accented Putonghua speech using minimal adaptation data.
- More specifically: look at various combinations of pronunciation and acoustic model adaptation.
- Demonstrate that “accentedness” is a matter of degree, and should be modeled as such.

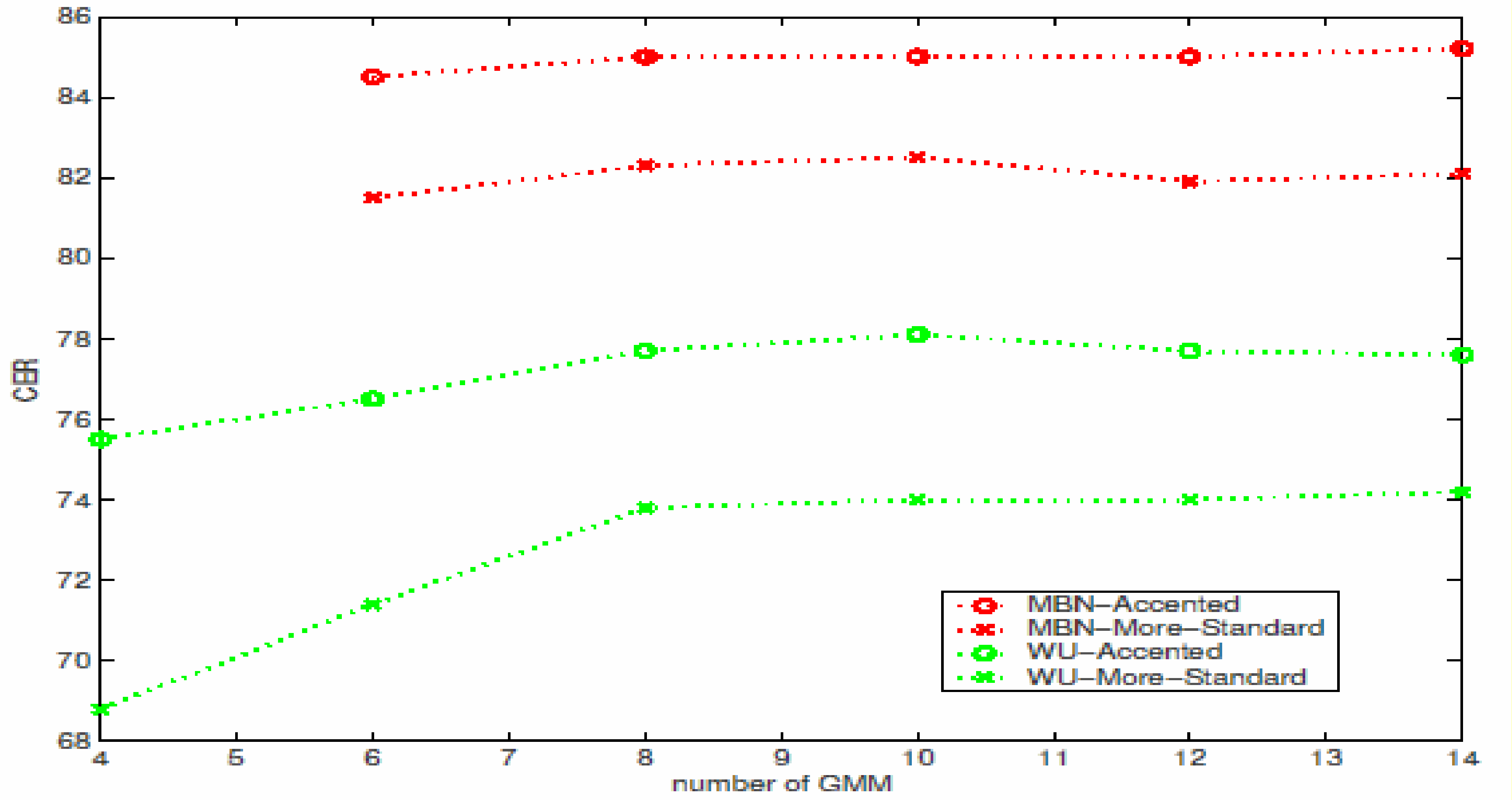
Data Redivision

- Original data division has proved inadequate since attempts to show differential performance among test-set speakers failed.
- We redivided the corpus so that the test set contained ten strongly accented and ten weakly accented speakers.
- New division has 6.3 hours training and 1.7 hours test data for spontaneous speech.

Baseline Experiments

- Two acoustic models:
  - Mandarin Broadcast News (MBN)
  - Wu-Accented Training Data
- Language model built on HKUST 100 hour CTS data, plus Hub5, plus Wu-Accented Training Data Transcriptions
- AM's with smaller # of GMM's per state generalize better and yield better separation of two accent groups.

Baseline Experiments



Oracle Experiment I

Add test-speaker-specific pronunciations to the dictionary:

sang hai		\`Shanghai’
sang he	1.39	
suo		\`speak’
shuo	1.67	
ze zong		\`this kind’
zei zong	1.10	
e men	1.10	\`we’
uo men		

Run recognition using the modified dictionary

Preliminary Oracle Results

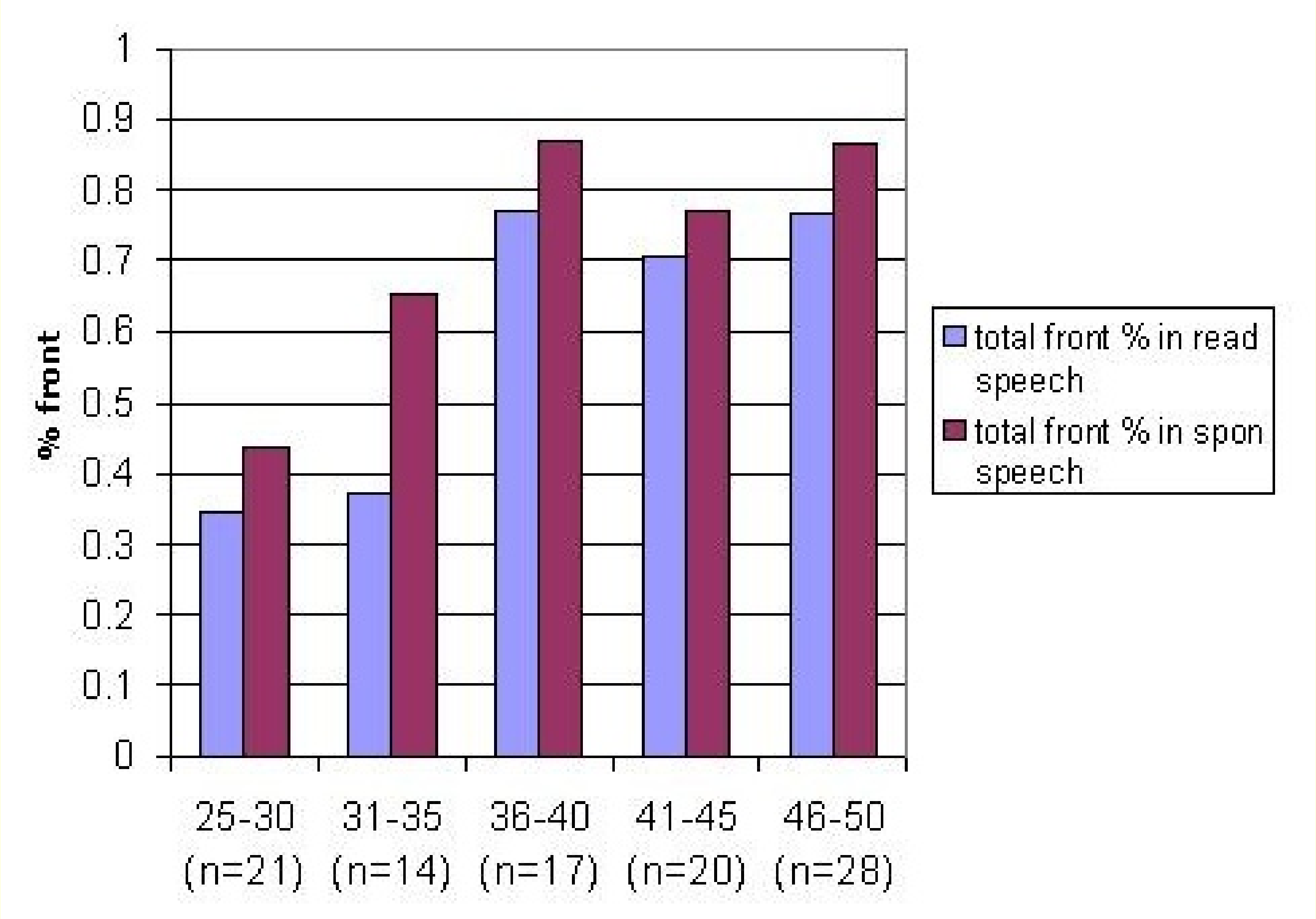
- So far we have been unable to show any improvement using the Oracle dictionaries.

“Accentedness” Classification

- General idea: accentedness is not a categorical state, but a matter of degree.

- Can we do a better job of modeling accented speech if we distinguish between levels of accentuation?

Younger Speakers More Standard: Percentage of Fronting (e.g. sh -> s)



“Accentedness” Classification

- Two approaches:
  - Classify speakers by age, then use those classifications to select appropriate models.
  - Do direct classification into accentedness

- The former is more “interesting”, but the latter seems to work better.

Age Detection

- Shafran, Riley & Mohri (2003) demonstrated age detection using GMM classifiers including MFCC's and fundamental frequency. Overall classification accuracy was 70.2% (baseline 33%)
- The AT&T work included 3 age ranges: youth (< 25), adult (25-50), senior (>50)
- Our speakers are all between 25 and 50. We divided them into two groups (<40, >=40)

Age Detection

- Train single-state HMM's with up to 80 mixtures per state on:
  - Standard 39 MFCC + energy feature file
  - The above, plus three additional features for (normalized) f0: $f0, \Delta f0, \Delta\Delta f0$
  - Normalization: $f0norm = log(f0) – log(f0min)$ (Ljolje, 2002)
- Use above in decoding phase to classify speaker's utterances into "older" or "younger"
- Majority assignment is assignment for speaker

Age Detection (Base = 11/20)

Train \ Test	*Spontaneous*		*Read*	
	MFCC	**MFCC+f0**	**MFCC**	**MFCC+f0**
Spontaneous	**13**	**14**	**14**	**10**
Read	**13**	**12**	**13**	**14**

Accent Detection

- Huang, Chen and Chang (2003) used MFCC-based GMM's to classify 4 varieties of accented Putonghua.
- Correct identification ranged from 77.5% for Beijing speakers to 98.5% for Taiwan speakers.

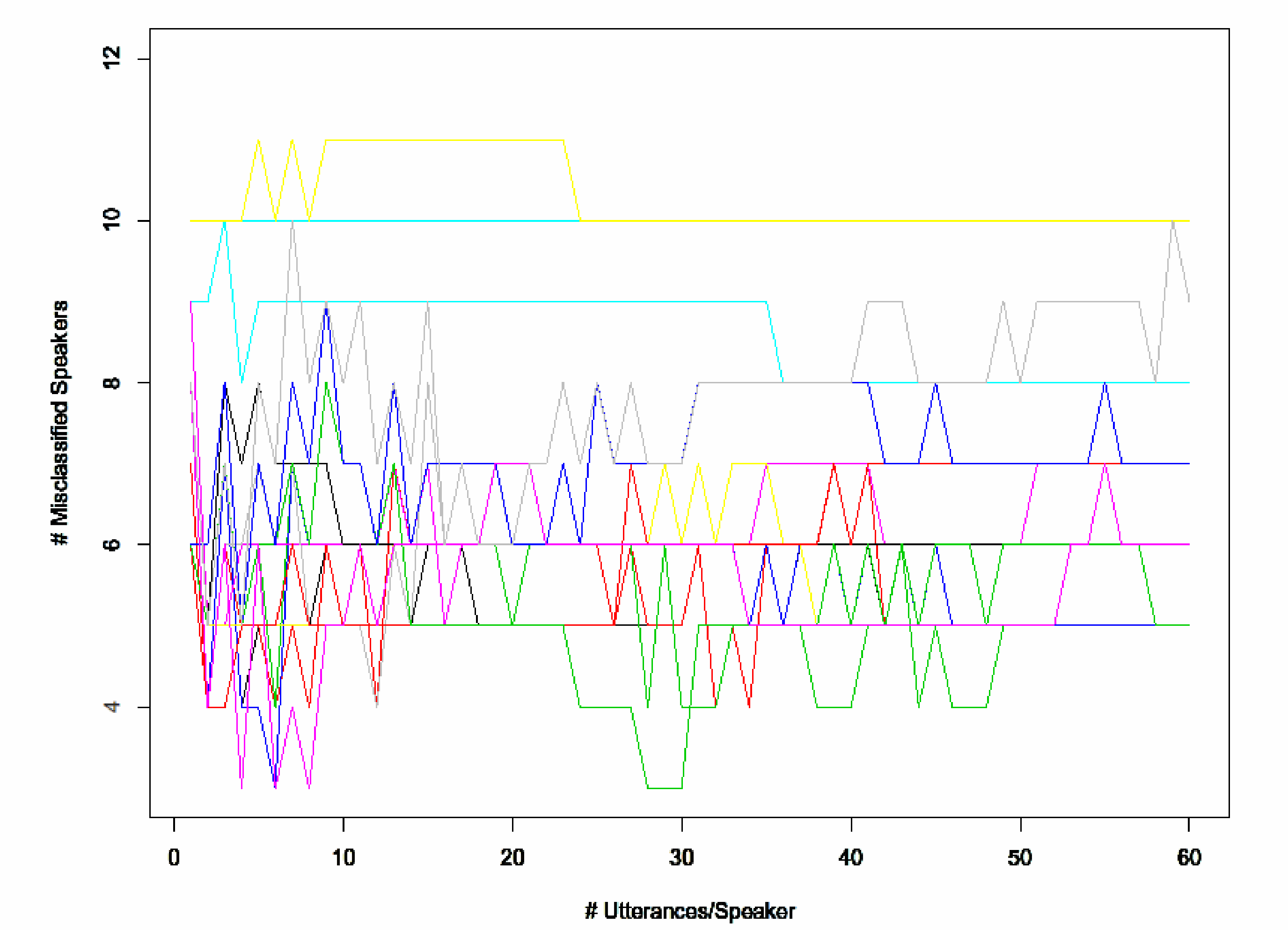
Accent Detection (Base = 10/20)

Train \ Test	*Spontaneous*		*Read*	
	MFCC	**MFCC+f0**	**MFCC**	**MFCC+f0**
Spontaneous	**12**	**15**	**11**	**10**
Read	**14**	**15**	**15**	**15**

Correlation between Errors

008	YOUNGER	2
009	YOUNGER	2
011	YOUNGER	2
012	YOUNGER	2
016	YOUNGER	2
032	YOUNGER	3
035	YOUNGER	3
043	OLDER	3
046	OLDER	3
047	OLDER	3
053	OLDER	3
054	OLDER	2
059	OLDER	3
061	YOUNGER	2
064	YOUNGER	2
066	YOUNGER	2
067	YOUNGER	2
076	OLDER	3
098	OLDER	3
099	OLDER	3

Utterances Needed for Classification



Rule-based Pronunciation Modeling (1)

- Motivation: using less data to obtain dialectal recognizer from PTH recognizer

- Data:
  - *devtest* set - 20 speakers' dialectal data taken from the 80-speaker *train* set
  - *test* set - 20 speakers' dialectal data (10 more standard plus 10 more accented)

- Mapping: (*pth*, *wdc* [, *Prob*])
  - *pth*: a Putonghua IF (PTH-IF)
  - *wdc*: a Wu dialectal Chinese IF (WDC-IF), could be either a PTH-IF, or a Wu dialect specific IF (WDS-IF) unseen in PTH.
  - {WDC-IF} = {PTH-IF} + {WDS-IF}
  - *Prob* = Pr {*WDC-IF* | *PTH-IF*, *WDS-IF*), can be learned from WDC *devtest*

Rule-based Pronunciation Modeling (2)

- Observations on WDC data:
  - Mapping pairs almost the same among all three sets (train, devtest, test)
  - Mapping pairs almost identical to experts' knowledge;
  - Mapping probabilities also almost equal;
  - Syllable-dependent mappings consistent for three sets.

- Remarks:
  - Experts' knowledge can be useful;
  - Can use less data to learn rules, and adapt the acoustic model
  - Feasible to generate pronunciation models for dialectal recognizer from a standard PTH recognizer with minimal data

Rule-based Pronunciation Modeling (3)

- Observations on more standard vs. more accented speech:
  - **Common points:**
    - As a whole, the mapping pairs and probabilities (as high as 0.80) are the same, and quite similar to those summarized by experts, for 35 out of 58.
  - **Differences:**
    - More standard speakers can utter some (but not most!) IFs significantly better;
    - Over-standardization more often for more accented speakers.
  - **Remarks:**
    - Pairs (*zh*, *z*), (*ch*, *c*), (*sh*, *s*), (*iii*, *ii*) as well their corresponding reverse pairs seem to be important to identify the PTH level;
    - We don't see other significant differences. Still unclear what features people use in identifying "standardness" in a speaker.

Rule-based Pronunciation Modeling (4)

- *Preliminary experimental results* (w/o AM adaptation)

	Word (%C, %A)		Char (%C, %A)	
Baseline	7.49	3.04	14.78	8.70
+ bigram	23.91	20.91	30.81	27.83
+ PTH-IF mapping	7.58	4.22	15.06	8.71
+ PTH-IF mapping + bigram	24.31	21.69	31.52	28.38
+ PTH-IF mapping + ProbLex + bigram	24.23	21.67	31.45	28.34

%C: %Correct, %A: %Accuracy

Work in Progress: Phonetic Substitutions

- Ratio of certain phones – s/sh, c/ch, z/zh, n/ng – is indicative of accentedness.
- How confident can one be of the true ratio within a small number of instances. For 20 instances:

  s/sh: 76% confident within 10% of true ratio

  z/zh: 88% ……………….. 10% …………..

  c/ch: 75%…………………10%……………

  n/ng: 81%…………………10%……………
- Number of utterances required to get 20 instances:

  s/sh 9; z/zh 14; n/ng 3.5

Further Dictionary Oracles

- “Whole dialect” oracle: use pronunciations found in all of training set for Wu-accented speech.
- “Accentedness” oracle: have two sets of pronunciations, one for more heavily accented and one for less heavily accented speakers.

MAP Acoustic Adaptation

- Use Maximum a posteriori (MAP) adaptation to compare results of adapting to:
  - All Wu-accented speech
  - Hand-classified groups
  - Automatically-derived classifications

Minimum Perplexity Word Segmentation

- Particular word segmentation for Chinese has an effect on LM perplexity on a held-out test-set. E.g.:

Character bigram model:	*perp = 114.78*
Standard Tsinghua dictionary:	*perp = 90.11*
Tsinghua dictionary + 191 common words:	*perp = 90.71*

- Is there a "minimum perplexity" segmentation?