Acoustic modelling of English-accented and Afrikaans-accented South African English

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Introduction

South African accents of English

- English is the language of government, commerce and science
- Only 8.2% of the population use English as first language
- Results in various accents (not regionally bound)
- Multi-accent speech recognition particularly relevant in SA

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Aim of research

Determine whether data from different South African English accents can be combined to improve speech recognition performance in any one accent

- Afrikaans-accented English (AE)
- South African English (EE)

Speech Databases

- African Speech Technology (AST) databases
  - Afrikaans English (AE) database
  - South African English (EE) database
- Training set: Approximately 6 hours of speech in both accents
- Test set: Approximately 24 minutes of speech from 20 speakers in each accent
- Development set: Used to optimise recognition parameters

Decision-Tree State Clustering

Acoustic modelling of context-dependent phones

- Acoustic modelling of triphones: [j]−[i]+[k]
- Problems:
  - Not all triphones occur in the training data
  - Not enough data for some triphones which do occur
- Want to determine clusters of similar triphones which can then be used to obtain individual models

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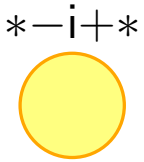
Solution

Use decision-tree state clustering

Decision-Tree State Clustering



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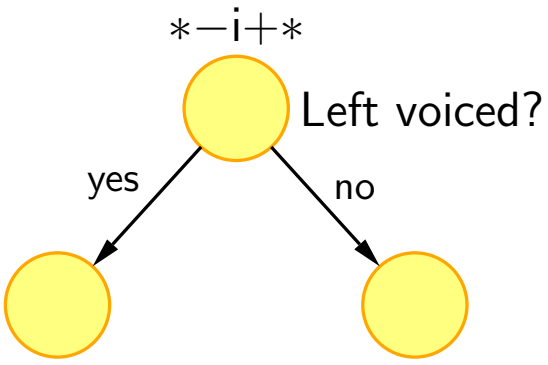

- Begin by pooling all triphones with the same basephone
- Use linguistically-motivated questions to split clusters
- Choose question yielding greatest likelihood improvement and split

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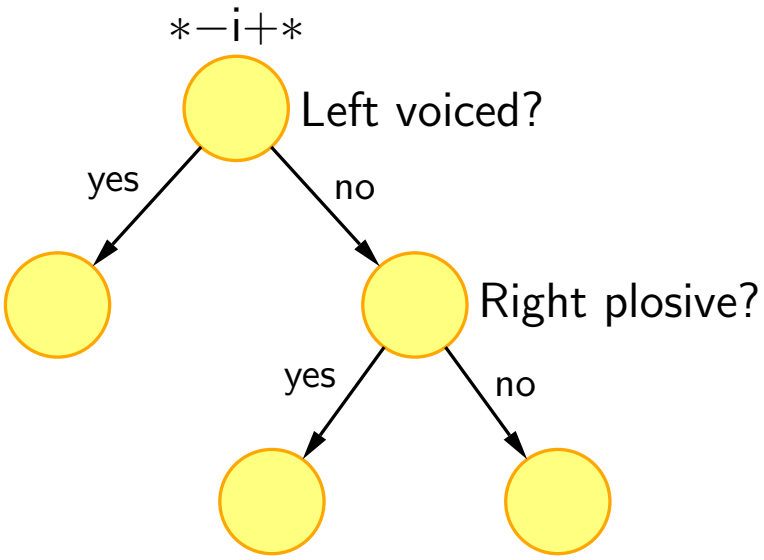

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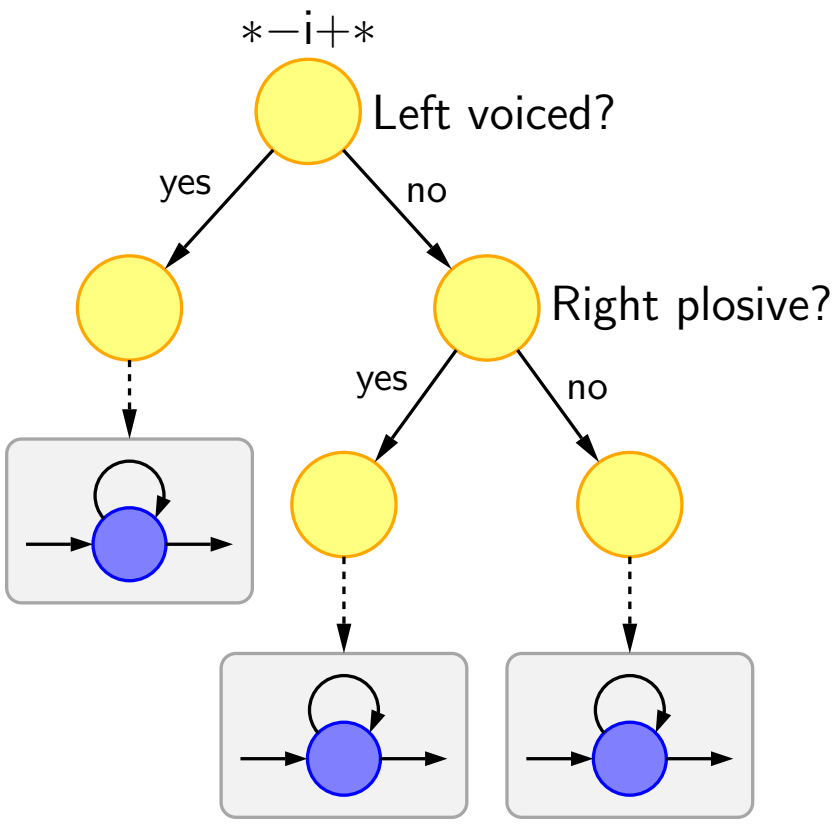

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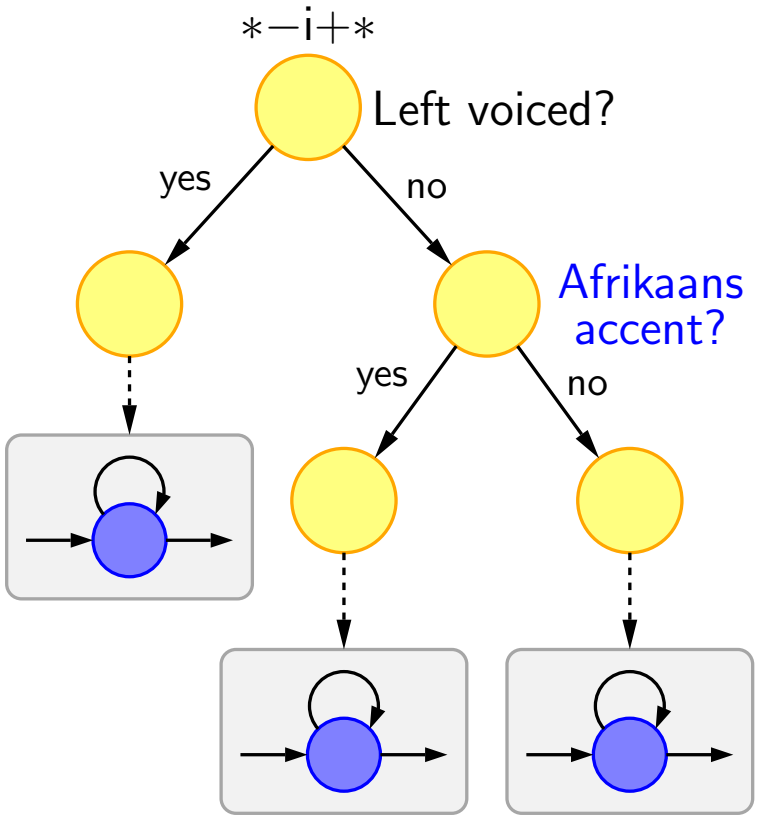
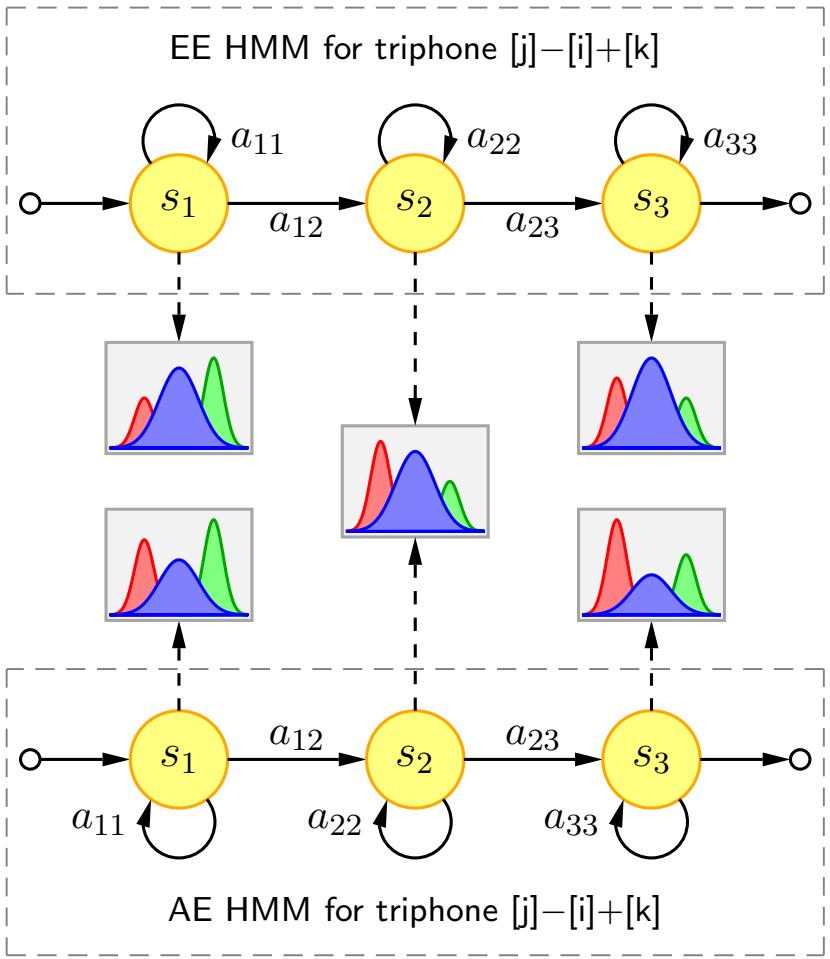
- Each tree leaf corresponds to a cluster of HMM states

Multi-Accent Decision-Tree State Clustering



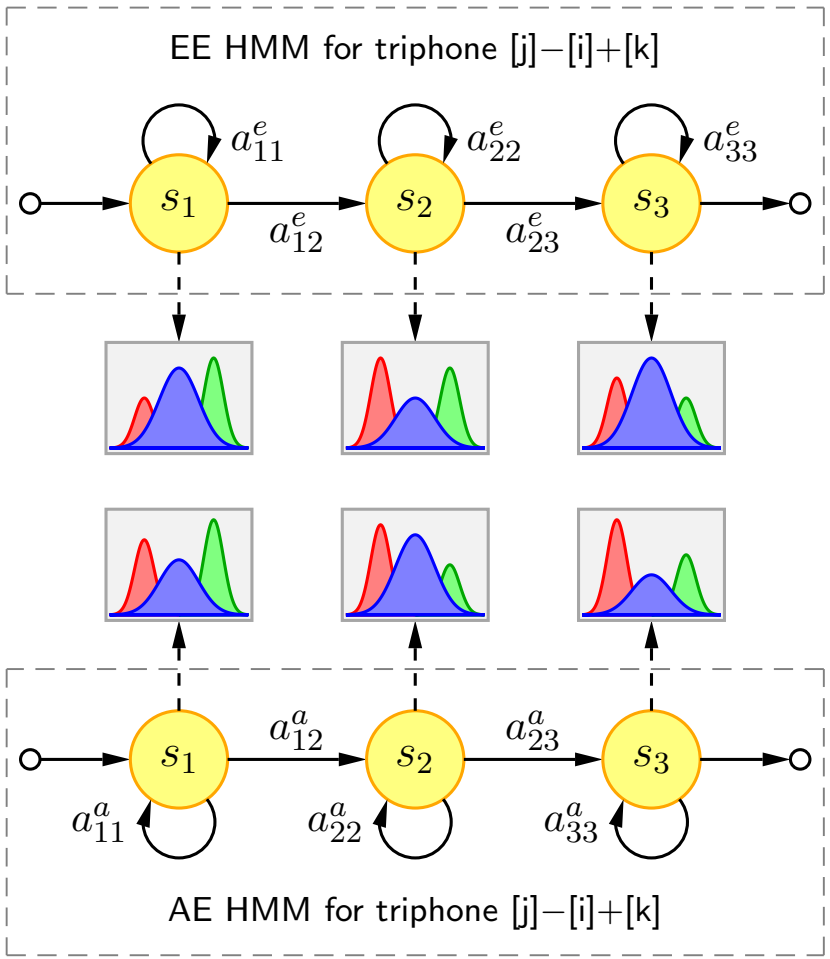
- Tag phones with accent before pooling at root nodes
- Allow decision-tree questions regarding accent as well as phonetic context
- Automatically determine if triphone states from different accents are similar

Multi-Accent Acoustic Models



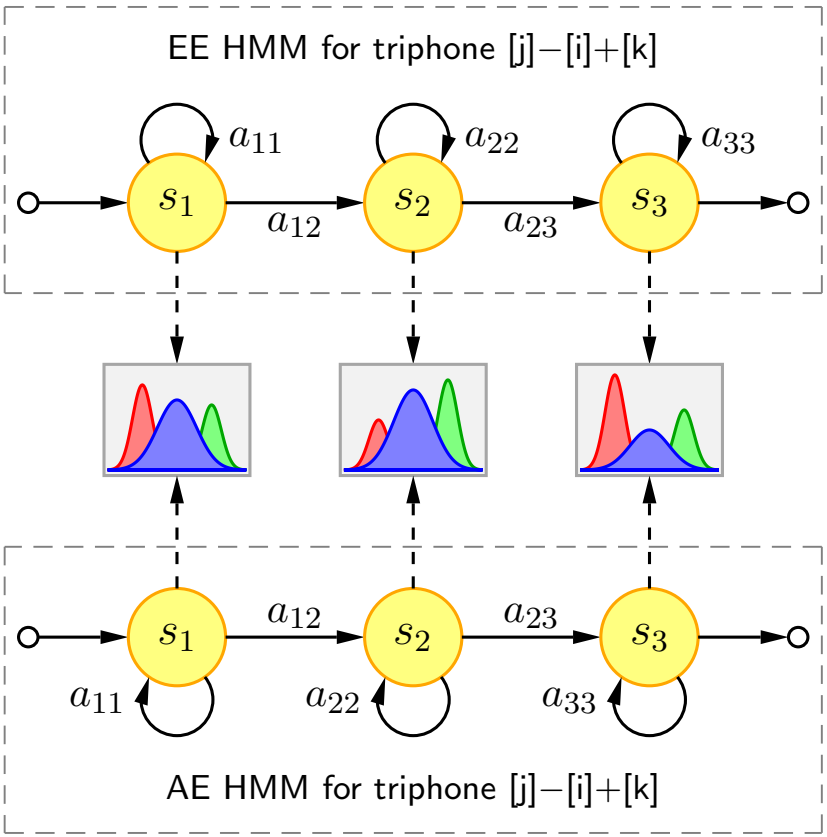
- Allow sharing between accents
- Single set of decision-trees is grown for both accents
- Clustering process employs questions relating to both accent and phonetic context
- States corresponding to the same basephone but different accents may be shared or kept separate

Accent-Specific Acoustic Models



- Allows no sharing between accents
- Separate decision-trees are grown for each accent
- Clustering process employs only questions relating to phonetic context
- Completely separate set of acoustic models for each accent

Accent-Independent Acoustic Models



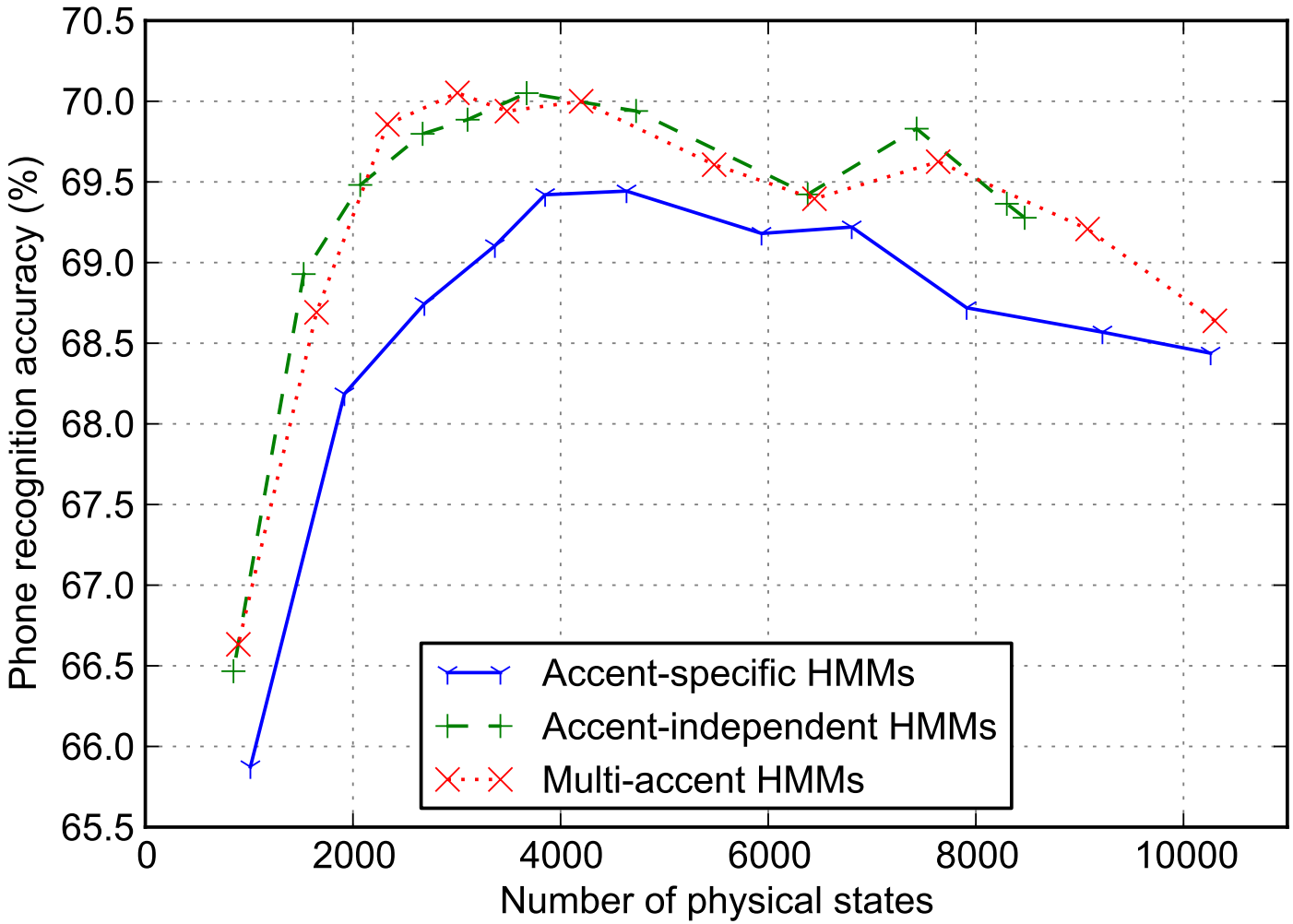
- Data are pooled across both accents
- Single set of decision-trees is grown for both accents
- Clustering process employs only questions relating to phonetic context
- Single set of acoustic models for both accents

Experiments

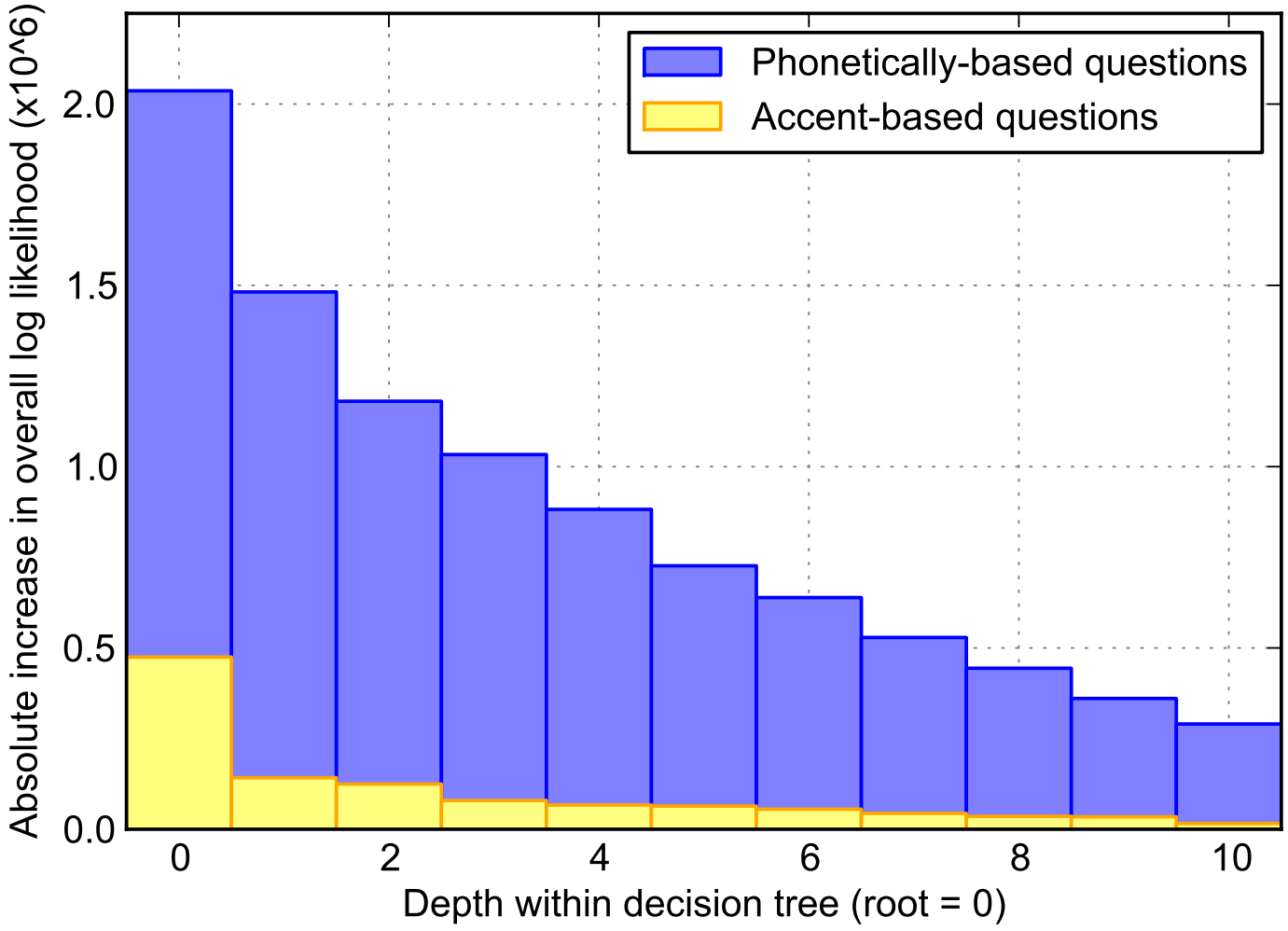
Common setup of systems

- Decision-tree likelihood threshold varied to produce models with different numbers of clustered states
- Used 8-mixture cross-word triphone HMMs
- Speech parameterisation: MFCCs, 1^{st} and 2^{nd} order derivatives, per-utterance CMN

Results: Phone Recognition Performance



Analysis of Decision Trees



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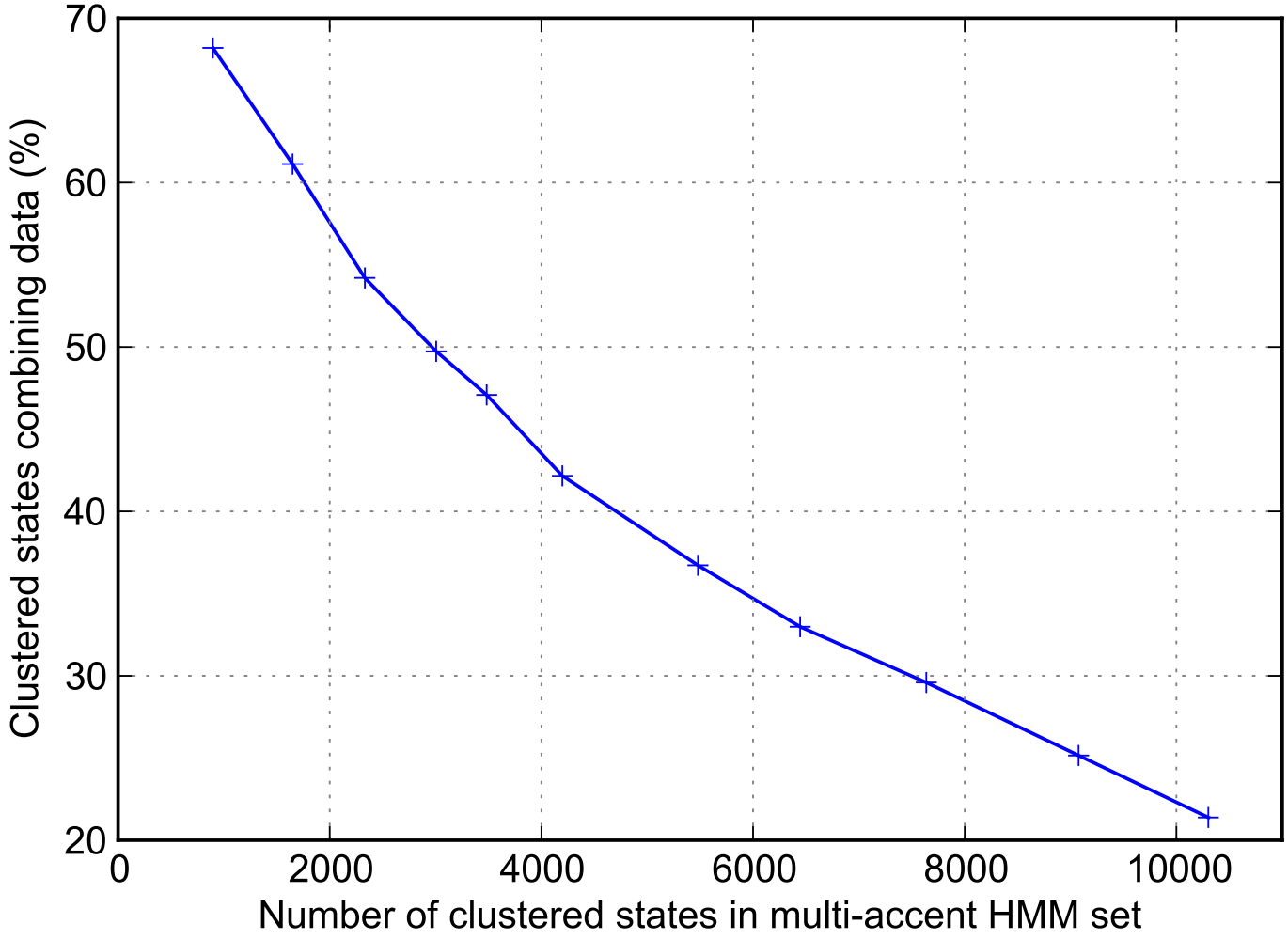
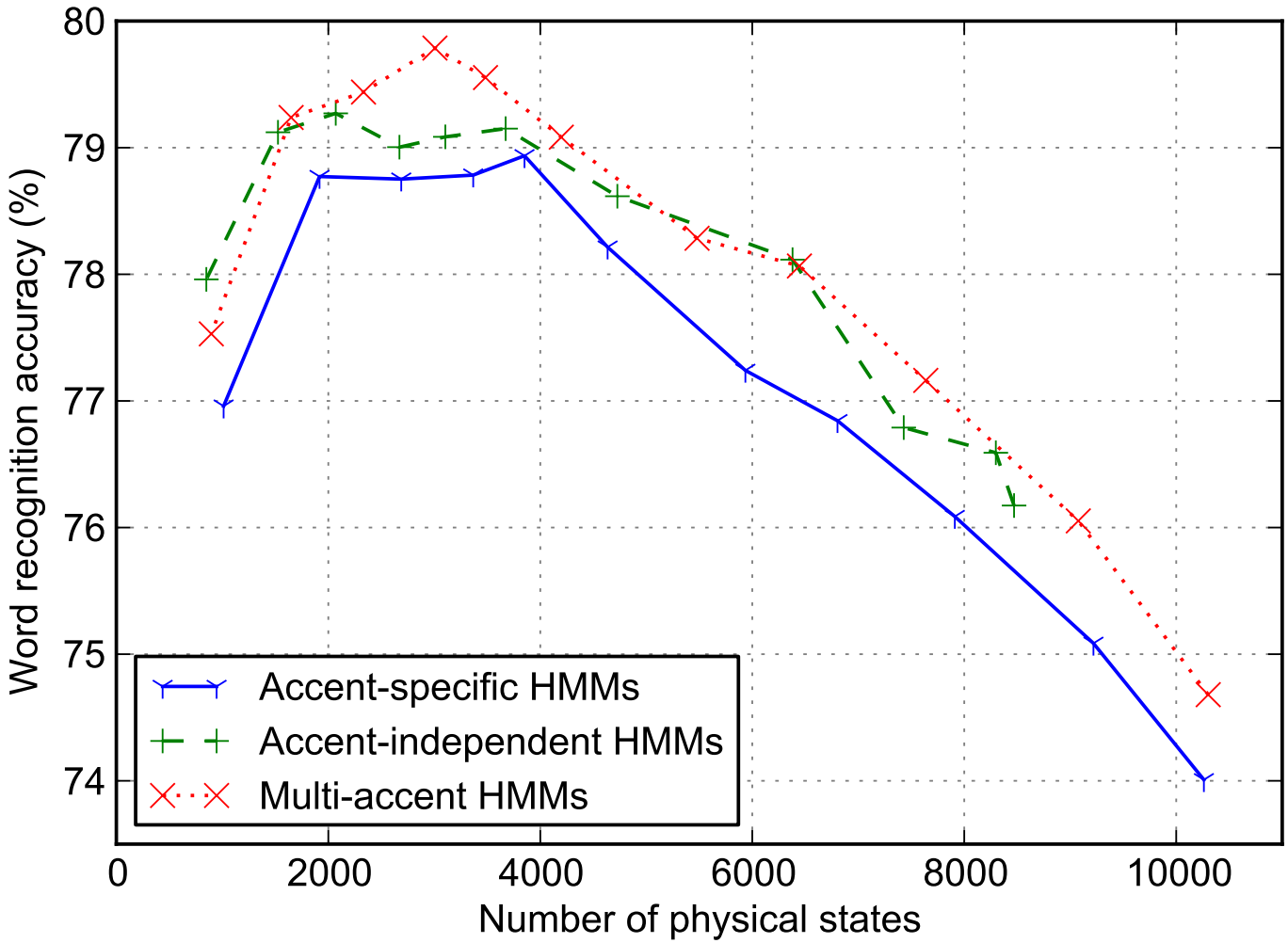


Results: Word Recognition Performance



Conclusions and Future Work

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- Accent-specific modelling performs worst
- Accent-independent and multi-accent acoustic modelling yields similar improvements (Afrikaans speaker proficiency)
- Inclusion of accent-based questions (selective sharing) does not impair recognition performance, but does not yield significant gain either
- Supports current practice of simply pooling English accents

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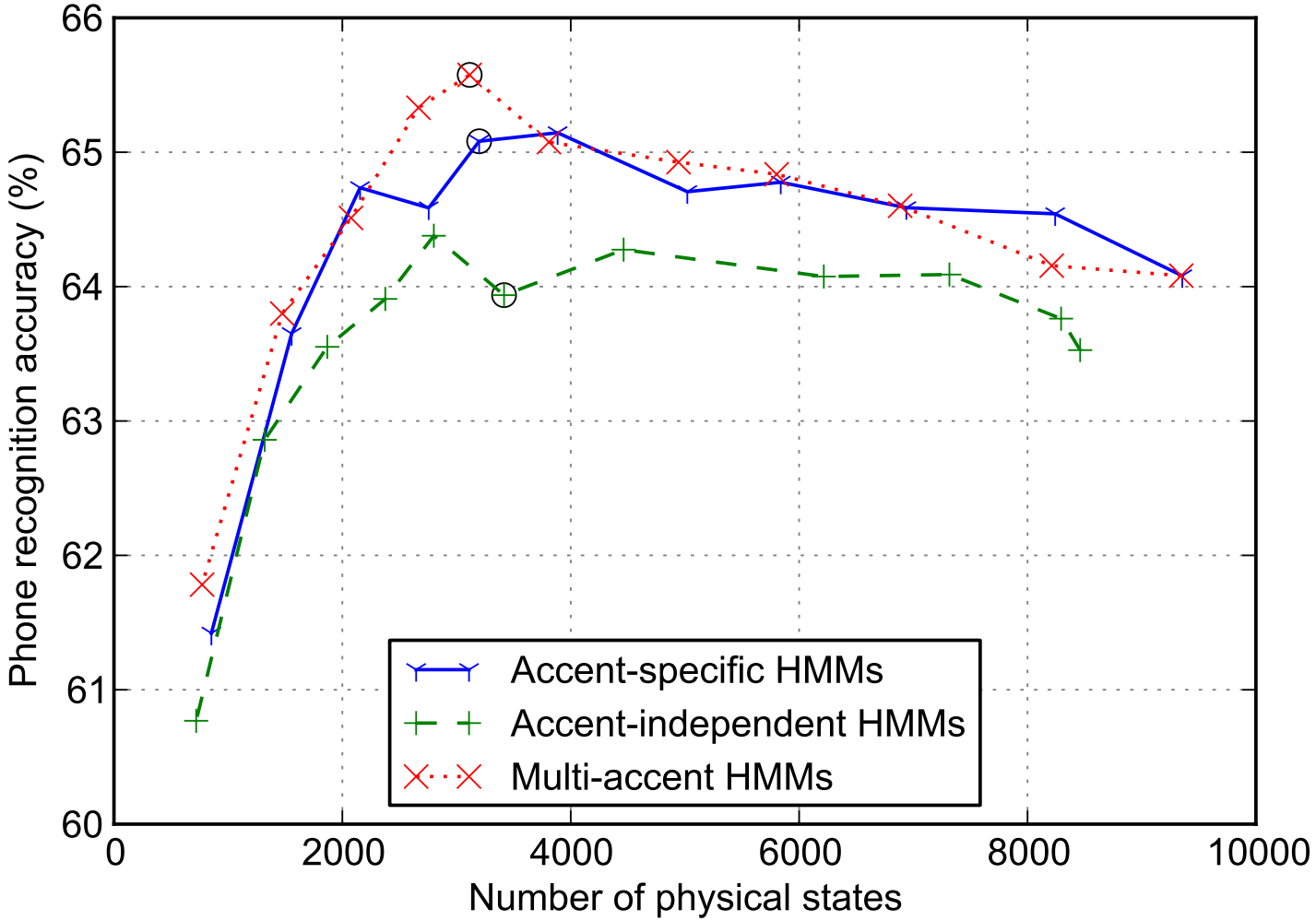
Future work

- Less similar accents: Black English and South African English
- Multi-accent acoustic modelling of all five SA English accents

Phone Recognition Performance: BE & EE



Language Modelling: Phone Recognition of AE