Extracting pronunciation rules for phonemic variants

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Overview

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Background

- Pronunciation model:
  - Maps orthography to phonemic realisation of word
  - Multilingual requirement: Fast development of pronunciation models in resource-scarce languages
- Pronunciation variation:
  - Predictive rewrite rules
  - Incorporation of phonemic variants
- Inclusion of explicit pronunciation variants:
  - Difficult to ensure consistency
  - Difficult to use grapheme-to-phoneme rule extraction to generalise

Generating pseudo-phonemes

- Single model for two or more phonemes consistently occurring as variants of single word.

Word	Variants	Pseudo-phoneme	New pronunciation
animate	ae n I m ay t Φ	p_1 = ay||ax	ae n I m p_1 t Φ
	ae n I m ax t Φ		
delegate	d eh l ih g ay t Φ	p_1 = ay||ax	d eh l ih g p_1 t Φ
	d eh l ih g ax t Φ		
lens	l eh n z	p_2 = s||z	l eh n p_2
	l eh n s		
close	k l ow z Φ	p_2 = s||z	k l ow p_2 Φ
	k l ow s Φ		

Generation restriction rules

- Example: second
  - Valid: */s eh k ih n d/*
  - Valid: */s ih k aa n d/*
  - Invalid: */s ih k ih n d/*
  - Invalid: */s eh k aa n d/*

  - Valid combinations: always *eh;ih* and *ih;aa*
  - Use Default&Refine to extract rules

Process

- Align training dictionary
- Generate pseudo-phonemes
- Rewrite aligned dictionary in terms of pseudo-phonemes
- Use D&R to extract pronunciation prediction rules
- Use D&R to extract generation restriction rules
- Predict test word lists i.t.o pseudo phonemes using standard D&R rule extraction
- Expand dictionary according to pseudo-phoneme mappings and generation restriction rules
- Evaluate accuracy of expanded lexicon

Benchmark systems

- Oxford Advanced Learners Dictionary (OALD)
- Excluding Part-of-Speech, Stress assignment

Approach	**Word accuracy**		**Phoneme accuracy**		**Phoneme correctness**	
CART [Black *et al*]	76.92	-	-	-	96.36	-
		σ_{10}		σ_{10}		σ_{10}
D&R: one variant	86.46	0.15	97.41	0.03	97.67	0.03
D&R: no variants	86.87	0.16	97.49	0.03	97.74	0.03

Prediction of non-variants

- No detrimental effect on non-variant prediction

Approach	Word accuracy		Phoneme accuracy		Phoneme correctness	
		σ_{10}		σ_{10}		σ_{10}
D&R: no variants	86.93	0.16	97.50	0.03	97.75	0.03
D&R: pseudo-phonemes	86.92	0.15	97.50	0.03	97.76	0.03

Prediction of variants

- 58% of expected variants correctly generated
- 67% of generated variants correct
- Examples of cross-validation sets:

Correct	Missing	Extra	% correct of expected	% correct of generated
58	43	23	57.43	71.60
56	40	20	58.33	73.68
64	45	32	58.72	66.67

- Some “extra” may be legitimate, e.g.:
  - increase: both */iy n k r iy s/* and */iy ng k r iy s/*
  - Increased: only */iy n k r iy s t/* allowed

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Conclusions

- Process allows for incorporation of variants without adjusting standard rule extraction algorithm
- Applicable to additional g-to-p frameworks
- Applicable to additional lexicons (Fonilex, CMU-dict)
- Can use process to identify inconsistent variants within a lexicon