Learning Local Phonological Rules

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Phonological mappings

(1) German Final Devoicing

a. /ba:d/ $\mapsto$ [ba:t], 'bath'

b. /za:g/ $\mapsto$ [za:k], 'say'

Phonological mappings

(2) [+voice, -son] ⇒ [-voice] / __#

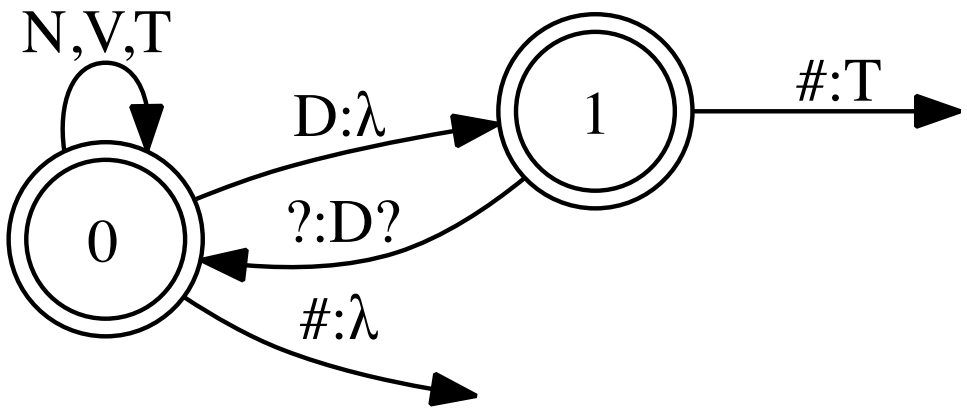
(3) *[+voice, -son]# >> IDENT(voice)

(4) (ba:d, ba:t), (za:g, za:k),...

Main objective

- Present and demonstrate an algorithm for the learning of phonological mappings that exploits a property (i.e. locality) of the linguistic data itself.

Phonological mappings



V = vowel
N = sonorant consonant
D = voiced obstruent
T = voiceless obstruent

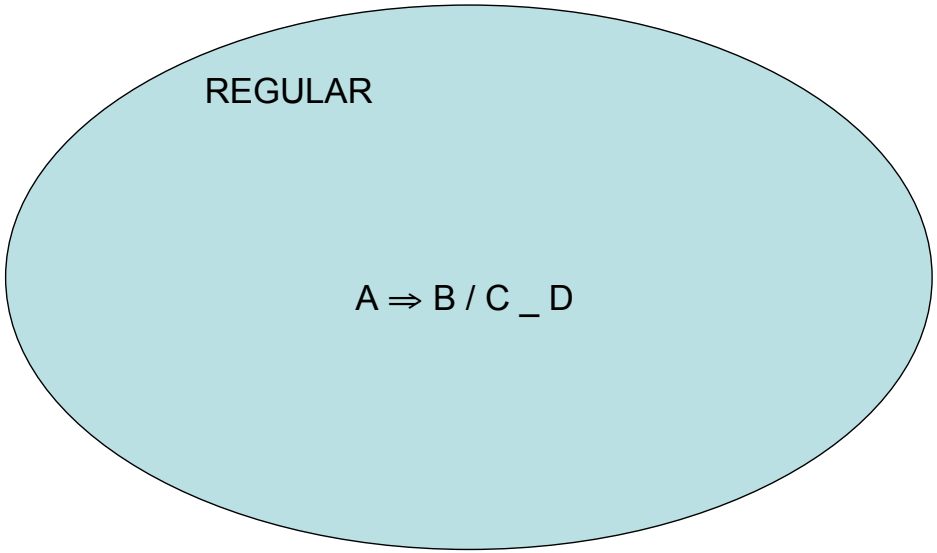
Locality in phonology

‘Normally, phonological rules do not count past two (which can be construed as not counting at all but simply examining one item in strict adjacency to another)’
(Kenstowicz, 1994, p. 372).

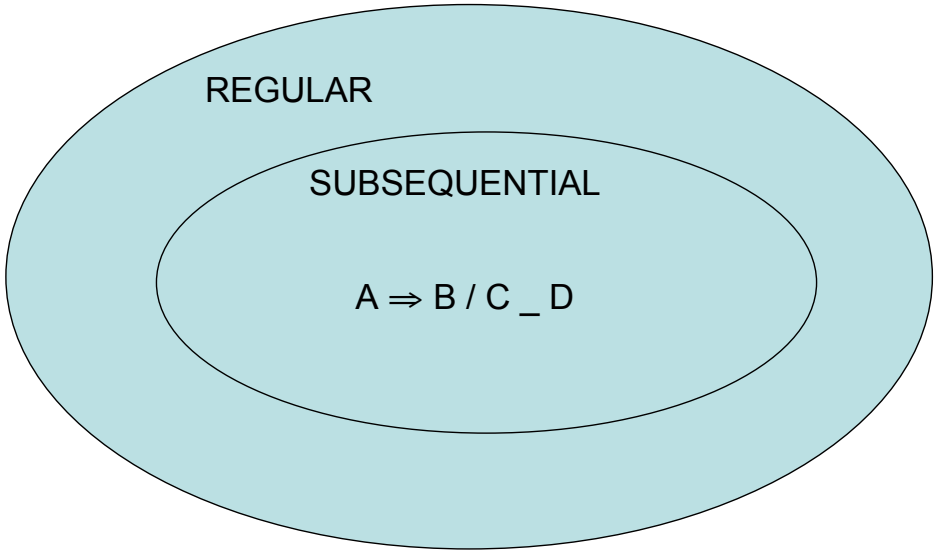
Learning in phonology

- Parameter setting (Gibson and Wexler 1994)
- SPE-style rules (Johnson, 1984; Gildea and Jurafsky, 1996; Albright and Hayes, 2002, 2003)
- Optimality Theory (Tesar and Smolensky, 1993; Tesar, 1995, 1998; Tesar and Smolensky, 1998; Alderete et al., 2005; Boersma, 1997; Boersma and Hayes, 2001; Hayes, 2004; Pater and Tessier, 2003; Prince and Tesar, 2004; Pater, 2004; Riggle, 2004, 2006, 2009; Merchant and Tesar, 2008; Magri, 2010, 2012)
- Phonotactic learning (Heinz, 2007, Hayes and Wilson, 2008, among others)

Kaplan and Kay (1994)



Subsequentiality

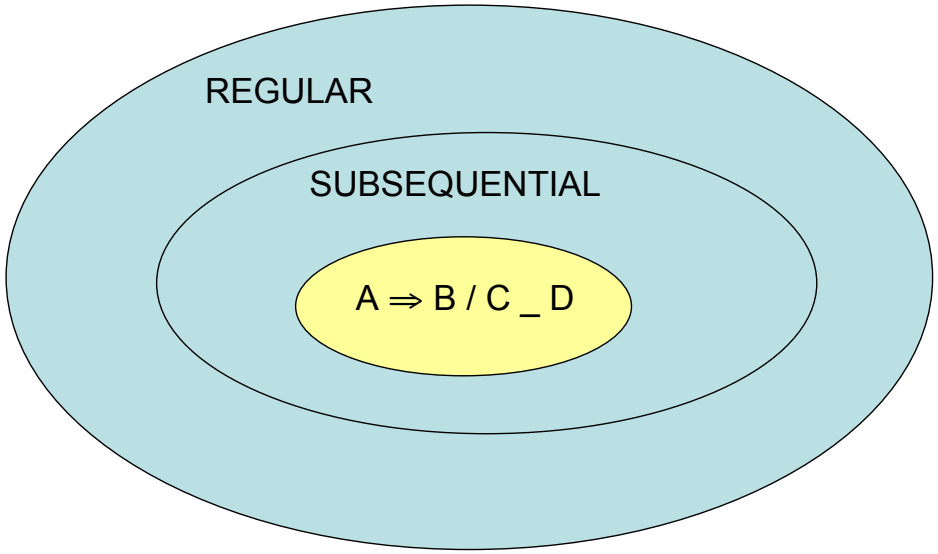


Many phonological processes are subsequential (Chandlee, Athanasopoulou, and Heinz, 2012, Gainor et al. 2012, Chandlee and Heinz, 2012).

OSTIA (Oncina et al., 1993)

- Subsequential functions are identifiable in the limit from positive data (Oncina et al., 1993).
- OSTIA failed to correctly generalize the English flapping rule (Gildea and Jurafsky, 1996).
- The characteristic sample necessary for the algorithm's success is not present in a natural language dictionary.

Using locality



Strictly Local Stringsets

String membership in a Strictly k-Local stringset can be determined by checking the substrings of length k (Rogers and Pullum, 2011).

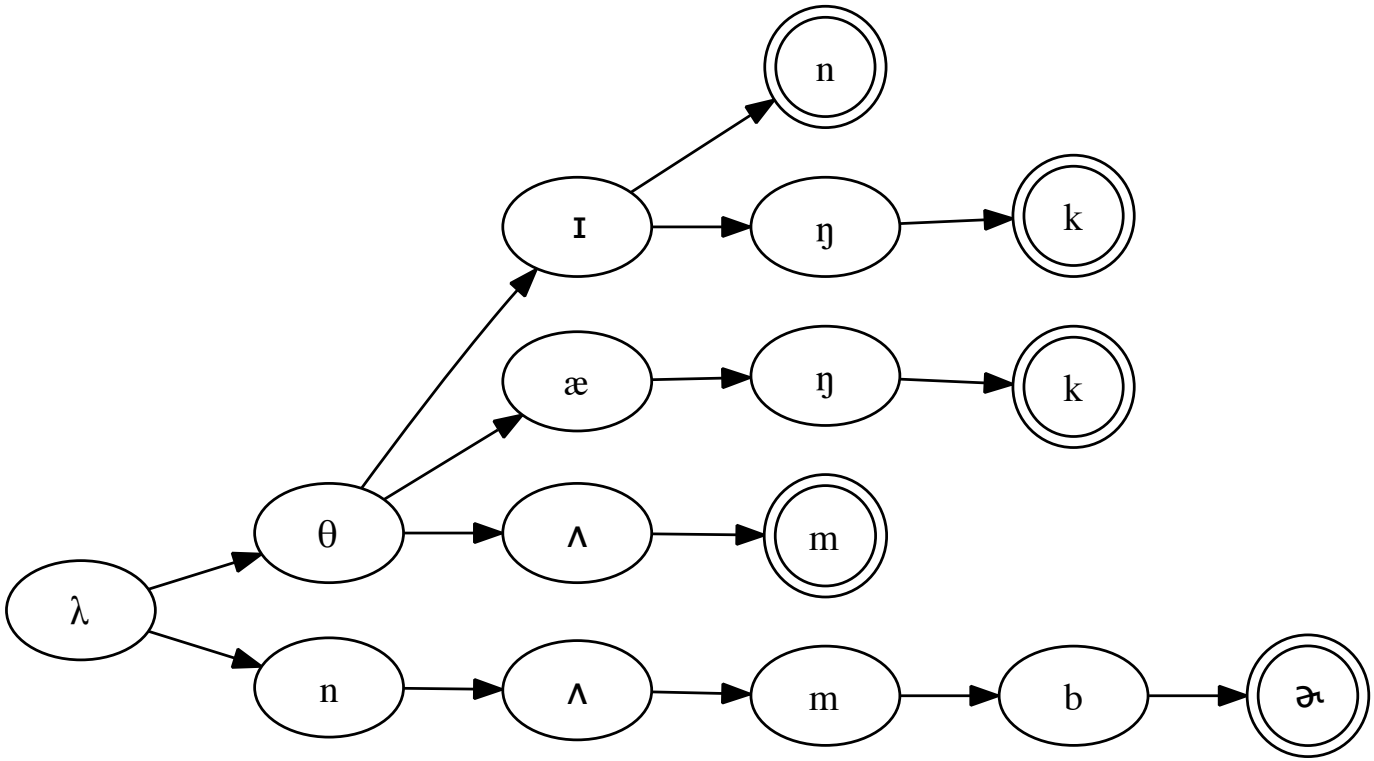
(5) a. [mb], [nt], [ŋk],...
b. *[nb], *[mt], *[ŋp],...

Learning SL stringsets (Garcia et al. 1990, Heinz 2007)

1. Prefix tree
2. State merging (Biermann and Feldman, 1972; Angluin, 1982; Hopcroft et al., 2001)

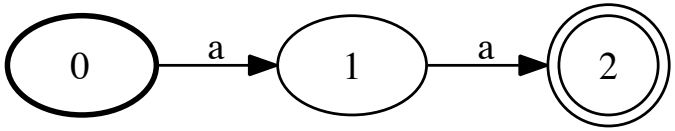
Prefix tree

{thin, think, thank, thumb, number}

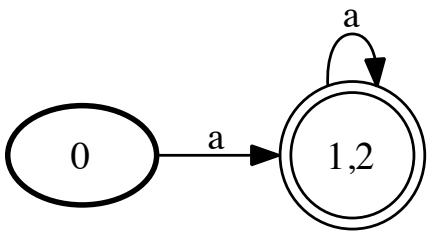


State merging

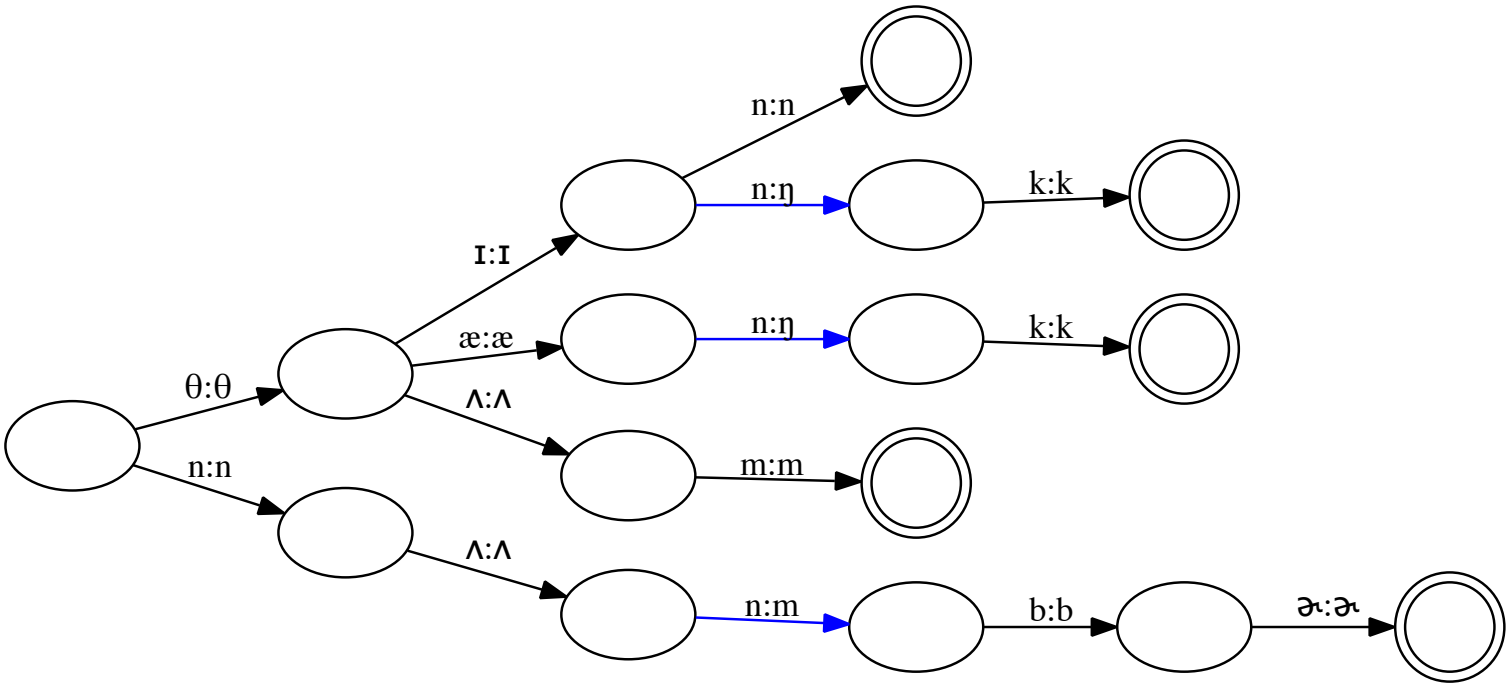
{ aa }



{ aa* }



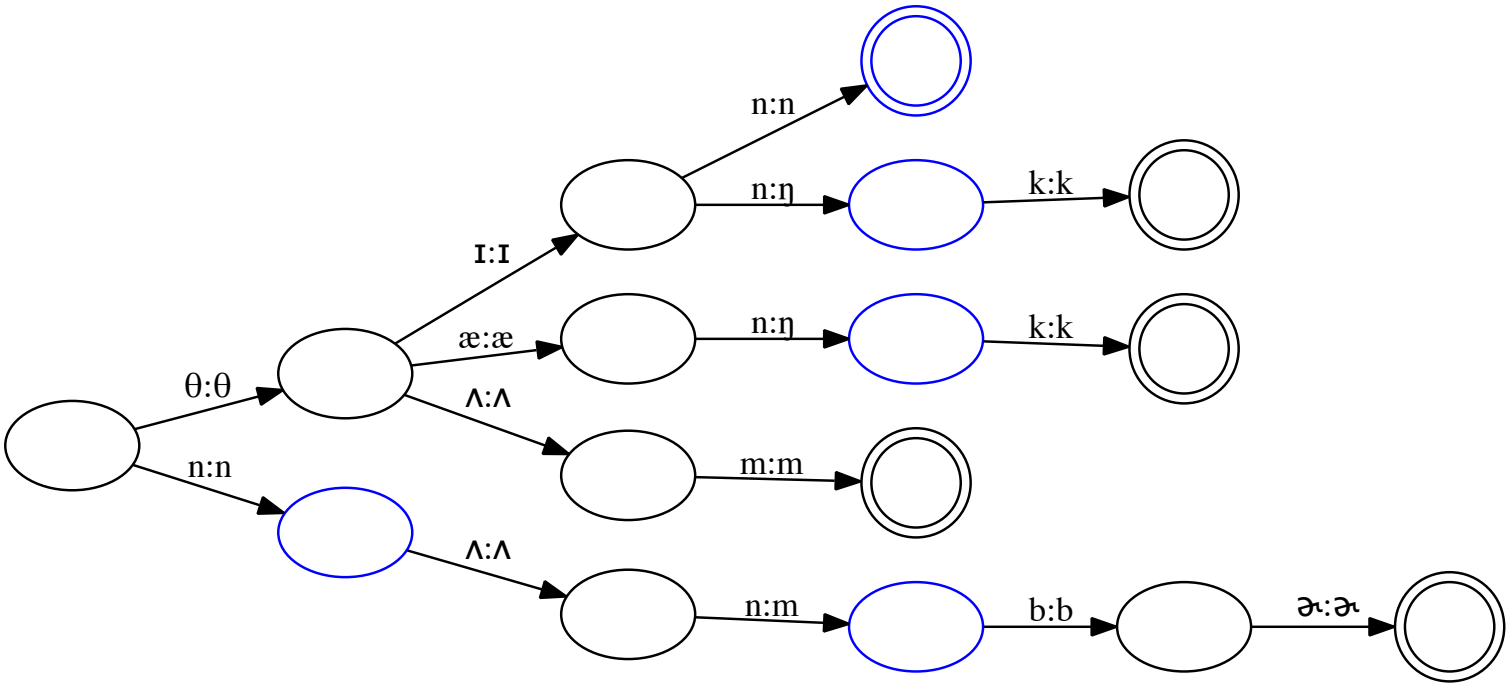
Prefix tree transducer



State merging

Merge states in the prefix tree with the same k-1 length suffix on the input side of the incoming transition.

State merging

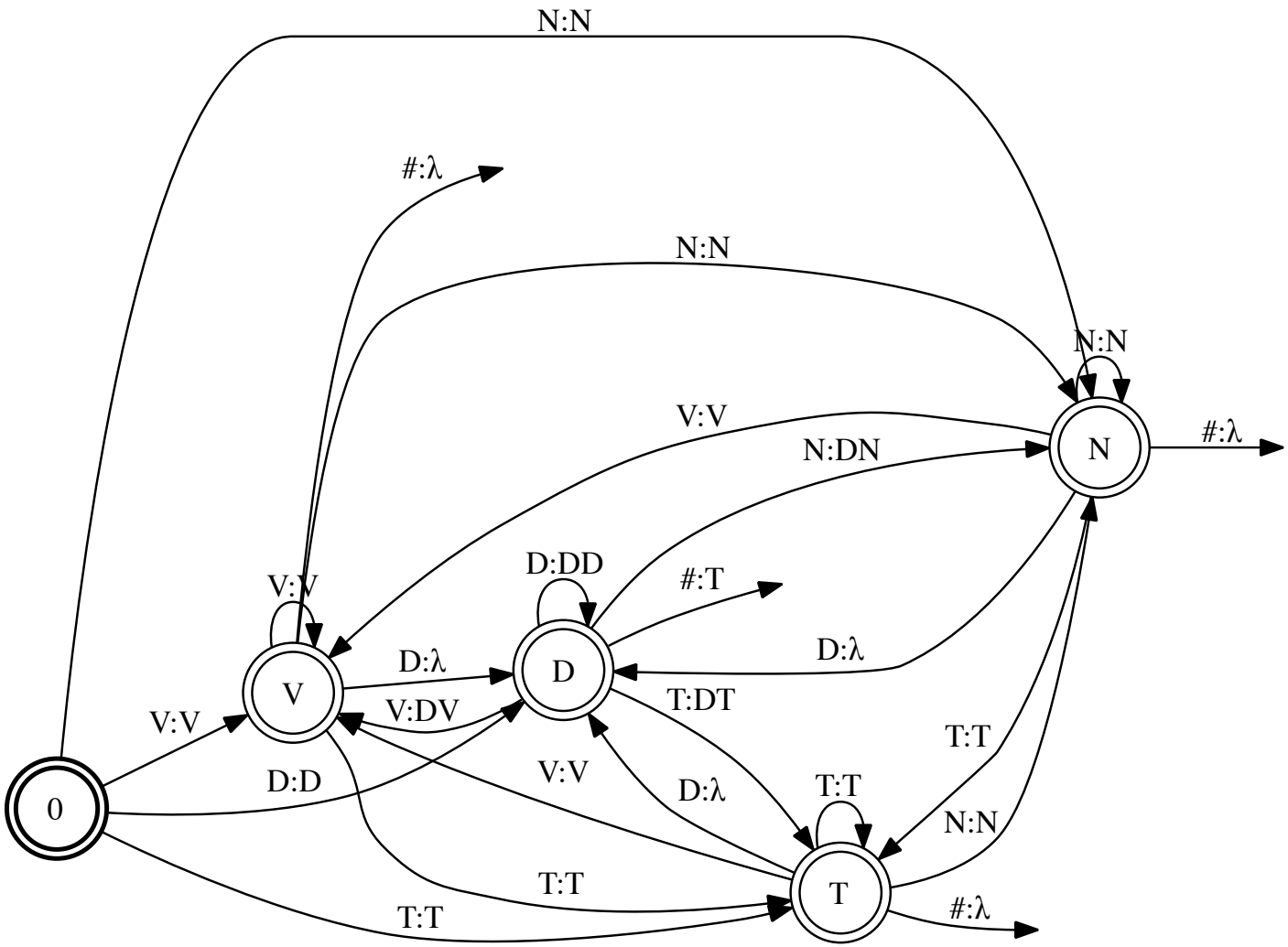


Learning German Final Devoicing

Data

- CELEX German lemmas
- 51,723 underlying-surface pairs: underlying final voiced obstruent posited when represented orthographically
- (...(ba:d, ba:t)...(grɪf, grɪf)...(sɛg, sɛk)...(za:g, za:k)...(zɪx, zɪx)...)
- (...(DVD, DVT)...(DNVT, DNVT)...(TVD, TVT)...(DVD, DVT)...(DVD, DVT)...(DVT, DVT)...)

Learning German Final Devoicing



Conclusions

- The property of locality is evident in phonological mappings regardless of the grammatical formalism used to describe them.
- We have shown that an algorithm that makes use of this property can generalize such mappings from positive data.
- These findings suggest a reason why, cross-linguistically, phonological processes are restricted in this way.

Next steps

- Proof of correctness
- Comparison of other state merging criteria
- Given a phonological mapping, determine whether it can be learned in this way (i.e., whether it is 'Strictly Local')
- Determine the characteristic sample necessary for the algorithm to succeed.

Acknowledgements

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