Strictly Local Phonological Processes

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Main objectives

- Propose a tighter computational characterization of phonological processes that apply locally.
- Define the class of Strictly Local functions, which can be shown to model such processes.
- Promote locality from a tendency to a defining property of many phonological processes.
Phonological mappings

- Final devoicing: (ba:d, ba:t)
- -son $\Rightarrow$ -voice / ___#
- *[son, +voice]# $\gg$ IDENT(voice)
Phonological mappings

- (CAD, CBD)
- $A \Rightarrow B / C \rightarrow D$
- $^*\text{CAD} >> \text{FAITH}(A \Rightarrow B)$ (Baković 2013)
- Locality as a property of the *mapping*.
- Tesar (to appear): phonological maps are output-driven
Overview

1. Strictly Local Languages and Phonotactics
2. Strictly Local Functions and Processes
3. Learning SL
4. Exclusions and Extensions
Class of formal languages describable with grammars of \( k \)-factors (= substrings of length \( \leq k \))

A string is in the language iff its own \( k \)-factors are a subset of the grammar.

Words can’t end in a voiced obstruent.

- SL-2 grammar that omits the 2-factor $D\#$, where $D = \{b, d, g, v, z, ʒ, dʒ\}$
(2) **Suffix Substitution Closure** (Rogers & Pullum 2011): A language is SL iff there is some $k$ such that for any string $x$ of length $k - 1$ and strings $u_1, v_1, u_2, v_2$ (of any length), if $u_1xv_1$ and $u_2xv_2$ are in the language, then $u_1xv_2$ must also be in the language.
Strictly Local Languages

- Canonical FSA for a SL-\( k \) language has \( Q = \Sigma^{\leq k-1} \).
- Transitions defined such that \( q \) = the most recent symbols of the input.
Canonical FSA for a SL-\( k \) language has \( Q = \Sigma \leq k-1 \).

Transitions defined such that \( q = \) the most recent symbols of the input.

\[ \Sigma^* aa \Sigma^* \]
SL languages and phonotactics

Strictly Local Phonological Processes

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Introduction

Strictly Local Languages

Strictly Local Functions

Phonological Processes

Future work
From sets to functions

Phonotactics
*b#
*d#
*g#

SL if the restriction is against a contiguous substring of bounded length (Heinz 2010).
From sets to functions

Phonotactics | Processes
---|---
*b#|→ p#
*d#|→ t#
*g#|→ k#
From sets to functions

(3) \( x_i \Rightarrow y_i \) / U __ V

<table>
<thead>
<tr>
<th>Phonotactics</th>
<th>Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>*ux_1 v</td>
<td>( \mapsto uy_1 v )</td>
</tr>
<tr>
<td>*ux_2 v</td>
<td>( \mapsto uy_2 v )</td>
</tr>
<tr>
<td>*ux_3 v</td>
<td>( \mapsto uy_3 v )</td>
</tr>
</tbody>
</table>

SL if there is an upper bound on the strings in UXV.
Automata-theoretic characterization

- The SL functions are believed to be a proper subset of the subsequential functions, which are those describable with subsequential finite state transducers (SFSTs).
- These FSTs are deterministic on the input and include a final output function that maps each state to a string, which is appended to the output if the input ends in that state (all states are final) (Mohri 1997).
Final devoicing

(4) $D \Rightarrow T / _- \#$
Final devoicing

Input: C V D
State: \( \lambda \)
Output:
Final devoicing

Input: C V D
State: λ ⇒ C
Output: C
Final devoicing

Input: C V D
State: \( \lambda \) \( \Rightarrow \) C \( \Rightarrow \) V
Output: C V
Final devoicing

Input: \[ C \quad V \quad D \]
State: \[ \lambda \Rightarrow C \Rightarrow V \Rightarrow D \]
Output: \[ C \quad V \quad \lambda \]
Final devoicing

Input: \( C \ V \ D \)

State: \( \lambda \Rightarrow C \Rightarrow V \Rightarrow D \)

Output: \( C \ V \lambda \ T \)
Final devoicing

**Input:** C V D V

**State:** λ ⇒ C ⇒ V ⇒ D ⇒ V

**Output:** C V λ DV λ
Mode of rule application

\[(5) \quad a \Rightarrow b \quad / \quad a \quad \rightarrow \quad a\]

Simultaneous  |  Left-to-right  |  Right-to-left
-------------|----------------|---------------
aaaa  \rightarrow abba  |  \rightarrow abaa  |  \rightarrow aaba

(Kaplan & Kay 1994)
Definition

A function $f$ is Strictly Local iff there is some $k$ such that $f$ can be described with a SFST for which $Q = \Sigma^{\leq k-1}$, and

- (simultaneous) $\forall q \in Q, a \in \Sigma, (q, a, o, \text{Suff}_{k-1}(qa)) \in \delta$
- (left-to-right) $\forall q \in Q, a \in \Sigma, (q, a, o, \text{Suff}_{k-1}(qo)) \in \delta$
Simultaneous application

(6) \( a \Rightarrow b / a \_ a \)

\( aaaa \rightarrow abba \)
Left-to-right application

(7) \( a \Rightarrow b \) / \( \_ \_ a \)

aaaa \( \mapsto \) abaa
What kinds of processes are SL?

1. Substitution

   \( x_i \Rightarrow \lambda / U \_ \_ V \)

2. Deletion

3. Epenthesis

   \( \lambda \Rightarrow y / U \_ \_ V \)

4. ‘Bounded’ metathesis
Metathesis

Metathesis = Delete ◦ Copy (Blevins & Garrett 1998, Heinz 2005, Chandlee & Heinz 2012)

(10) Rotuman (Churchward 1940)
   a. VCV# \rightarrow VVC#
   b. Copy: \lambda \Rightarrow V_1 / V \_ CV_1#
   c. Delete: V_1 \Rightarrow \lambda / VV_1C \_ #
 Metathesis

- ‘Long-distance’ metathesis

  (11) Cuzco Quechua (Davidson 1977)
  
  a. yuraq ⇒ ruyaq, ‘white’
  b. aBc ↦ cBa

- Still bounded if the length of all \( b \in B \) is bounded.
What kinds of processes are SL?

1. Substitution
2. Deletion
3. Epenthesis
4. ‘Bounded’ metathesis
5. Local partial reduplication/affixation
Local partial reduplication

(12) a. Local prefixation: $CVx \leftrightarrow CV-CVx$
b. Local suffixation: $xCV \leftrightarrow xCV-CV$
c. Local infixation: $C_1VCx \leftrightarrow C_1VC_1C_x$

(13) a. General prefixation: $un-x$
b. General suffixation: $x-\text{ing}$
What does this get us?

- Empirical coverage: at least 96% of the approx. 5500 processes in P-Base (v1.95, Mielke 2008) are Strictly Local
- Learning: SL functions can be learned with a modified OSTIA (Ocina et al. 1993) that uses strict locality as a learning bias (Chandlee & Jardine 2013, Chandlee & Koirala 2014)
Learning SL

- Regular
- Left
- Subsequential
- SL
- Right
- Subsequential
What *isn’t* SL?

- Nonlocal partial reduplication (Riggle 2003)
- Vowel harmony with transparent vowels (Nevins 2010, Gainor et al. 2012, Heinz & Lai 2013)
- Dissimilation (Suzuki 1998, Bennett 2013, Payne 2013)
- Some tonal patterns (Jardine 2013)
Future work

Future work

Future work

References

References

English flapping

(14) \[ t \Rightarrow r / \breve{V} V (k = 3) \]
Greek fricative deletion (Joseph & Philippaki-Warburton 1987)

(15) \( \{\theta, \delta\} \Rightarrow \lambda / \_ \{s, \theta\} \ (k = 2) \)
Dutch schwa epenthesis (Warner et al. 2001)

(16) $\lambda \Rightarrow \varepsilon / \{l, r\} \rightarrow [-\text{coronal}]$ ($k = 3$)