Multi-Input Strictly Local Functions for Tonal Phonology

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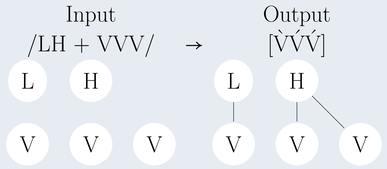
TONE

Tone is autosegmental

- Vowels surface with H or L tone
- Underlyingly the Vs and T's are on separate tiers
- Mende has left-to-right spread in *fèlámá* 'juncture'



Question: How local are tonal processes?
Answer: Tradeoffs in computation and data structure

Computing Tone:

String

- Regular (Bird and Ellison, 1994) but not local (Jardine, 2016a)
- Encoding systems needed (Kornai, 1995)
- String-encoded tones are at most regular (Yli-Jyrä, 2013, 2015)

Autosegmental Representations (ASRs) = *tone as graph*

- Local language (Jardine, 2016b, 2017)
- Some functions are Autosegmental-Input Strictly Local (A-ISL) (Koser et al., 2019; Chandlee and Jardine, 2019)

Multi-tape finite-state transducer (MT-FST)

- = *compute a graph flattened to string tuples*
- Sycnhronous MT-FST (Kiraz, 2000, 2001; Hulden, 2009)
- Asynchronous Non-deterministic MT-FST (Kay, 1987; Wiebe, 1992)

Multi-Input Strict Locality (MISL)

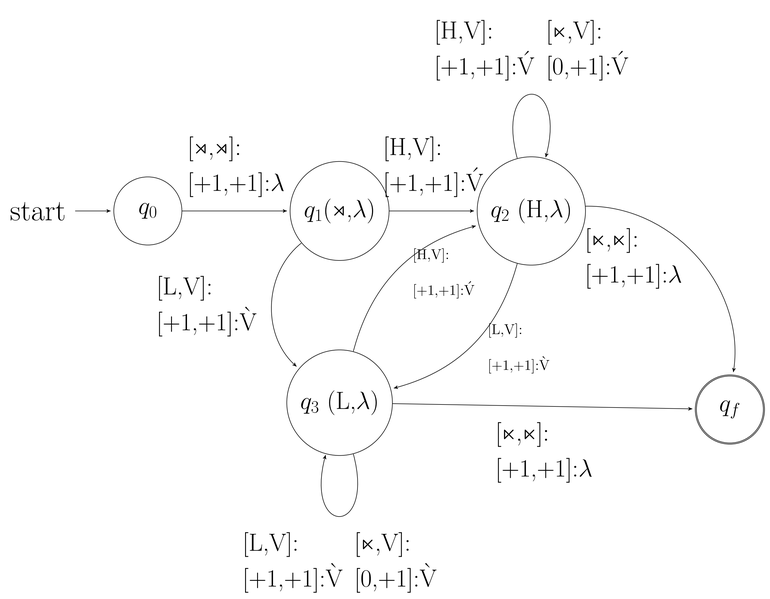
1-input function:	n-input function
$f(w)= v$	$f(\vec{w})= w$,
$w \in \Sigma^*$ is string	$\vec{w} \in (\Sigma^*)^n$ is tuple of strings w_i: [abc,de,fghi]
k is a natural number	$\vec{k}$ tuple of numbers k_i: [2,1,1]
suffix(w,k):	**suffix**$(\vec{w},\vec{k})$:
suffix(aba,2)=ba	**suffix**([abc,de,fghi], [2,1,1])= [bc,e,i]

Multi-Input Strictly Local
Input is 2+ strings on 2+ tapes
Deterministic + in one direction
Move (+1) or not (0) on a tape

M-ISL Multi-tape FSTs
f is MISL if its MT-FST M is
M is MISL if states are $\vec{k}$-suffix except initial and final state

Language-theoretic definition? In progress

Illustration: Mende Left-Right Spread



	Current state	Tone Tape	Vowel Tape	Output Symbol	Output string
1.	q_0	⋊HL⋉	⋊eaa⋉		
2.	q_1	⋊HL⋉ ⋊:+1	⋊eaa⋉ ⋊:+1	λ	
3.	q_2	⋊HL⋉ H:+1	⋊eaa⋉ e:+1	$\acute{e}$	$\acute{e}$
4.	q_3	⋊HL⋉ L:+1	⋊eaa⋉ a:+1	$\grave{a}$	$\acute{e}\grave{a}$
5.	q_3	⋊HL⋉ ⋉:0	⋊eaa⋉ a:+1	$\grave{a}$	$\acute{e}\grave{a}\grave{a}$
6.	q_f	⋊HL⋉ ⋉:+1	⋊eaa⋉ ⋉:+1	λ	$\acute{e}\grave{a}\grave{a}$

Table 1: Derivation of *HL + felama* over tone-vowel tiers *HL + eaa*

Mende is (2,1)-MISL =

- check window of size 2 on T: final T?
- check window of size 1 on V: any V?

Sample of Empirical Coverage

Language	Process	Pre-ass?	ISL	A-ISL	MISL	$\vec{k}$-value
Mende	Iterative left-right spread /LH + VVV/ → [ṲV́V́]	✗		✓*	✓	[2,1]
Kikuyu	Initial spread to two + final spread /LHLH + VVVVVVV/ → [ṲV̀V́V̀V́V́]	✗		✓*	✓	[2,3]
Hausa	Iterative right-left spread /LH + VVV/ → [ṲV̀V́]	✗		✓*	✓	[2,1]
Northern Shona	Edge-in + initial spread + medial spread /HLH + VVVVVV/ → [V́V́V̀V̀V́]	✗		✓*	✓	[4,6]
Kukuya	Quantity sensitive spreading /H + VVVV/ → [V́V́V́]	✗		✓*	✓	[4,2]
Rimi	Bounded tone shift /VV́VV/ → [VVV́V] /<H> + V<V>VV/	✓	✓	✓	✓	[1,2]
Zigula	Unbounded tone shift /VVV́VVV/ → [VVVV́V] /<H> + V<V>VV/	✓	✗	✓	✓	[1,3]
Bemba	Bounded tone spread /VV́VV/ → [VV́V́V] /<H> + V<V>VV/	✓	✓	✓	✓	[1,2]
Arusa	Unbounded deletion /V́ VV́VV/ → [V́VVVV] /<H> <H> + <V> V(VV)V/	✓	✗	✓	✓	[3,1]
Luganda	Bounded Meussen's rule /V́V́V́V/ → [V́V̀V̀V] /<H> <H> + <V>(VV)V/	✓	✓	✗	✓	[2,2]**
Shona	Alternating Meussen's rule /V́-V́-V́/ → [V́-V̀-V́] /<H>-<H>-<H> + <V>-<V>-<V>/	✓	✗	✗	✗	
Ndebele	Unbounded spreading to ante-penultimate /VVVVV/ → [V́V́VVV] /<H> + <V>VVVV/	✓	✗	✗	✓	[1,3]

Table 2: *Legend:* * Function was proved to be QFLFP by Koser et al. (2019), ** Function is MISL if the output is 2-tuple

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