Vowel Harmony is local over multi-tiered ARs

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Introduction

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- A unified theory of phonotactic constraints as forbidden substructure constraints over multi-tiered autosegmental representations captures a variety of vowel harmony patterns
  - ▶ neutral vowels: blocking in Akan, transparent vowels in Finnish
- Transparent vowels don't rely on underspecification

Why do we care?

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- Patterns that are complex with one representation can be simpler with a different representation
- ARs provide explanatory power
 - simpler subregular class than with strings (McMullin & Hansson, 2014; Aksënova, 2017; Aksënova & Deshmukh, 2018)

Locality

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- Attested vowel harmony patterns captured by static surface well-formedness constraints: forbidden substructure constraints (FSCs) (Jardine 2016, 2017)
- FSCs over ARs use two relations: association (|) and successor ($\rightarrow$)

Akan: [pɪrɜko] 'pig'
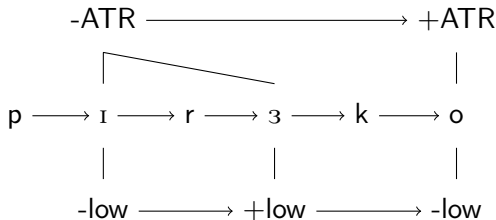
Autosegmental Representations (ARs)

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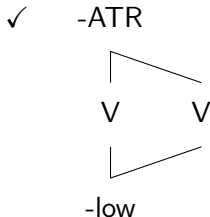- Vowel harmony can be represented with multiple featural tiers
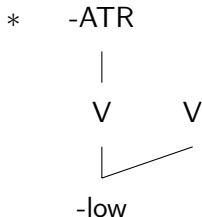
$\pm$ high

|

V

|

$\pm$ back

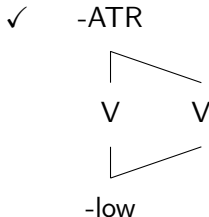# Representational Assumptions
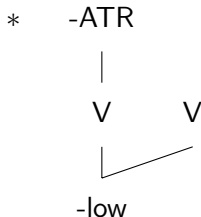
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Representational Assumptions

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- each featural element must be associated to at least one vowel
- each vowel must be associated to at least one element on each feature tier
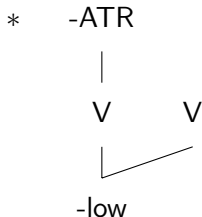
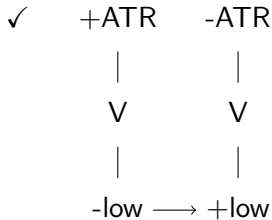# Representational Assumptions
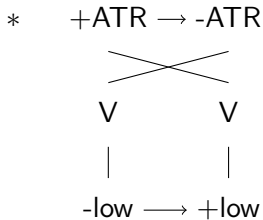
Full Specification (FS):

- each featural element must be associated to at least one vowel
- each vowel must be associated to at least one element on each feature tier
- consonants are not associated to vowel features
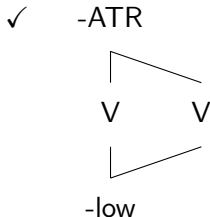
Representational Assumptions

No Crossing Constraint (NCC):

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No Crossing Constraint (NCC):

- association lines between the segmental tier and a feature tier never cross
- FS and NCC prevent gapped structures (Archangeli & Pulleyblank, 1994; Ringen & Vago, 1998)

Representational Assumptions

Obligatory Contour Principle (OCP):

- adjacent featural elements must be distinct

$$
\begin{array}{cccc}
* & \text{-ATR} \longrightarrow \text{-ATR} & \checkmark & \text{-ATR} \longrightarrow \text{+ATR} \\
 & | \qquad | & & | \qquad | \\
 & V \qquad V & & V \qquad V \\
 & | \qquad | & & | \qquad | \\
 & \text{-low} \longrightarrow \text{-low} & & \text{-low} \longrightarrow \text{+low}
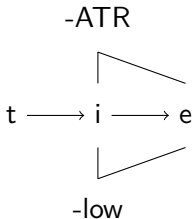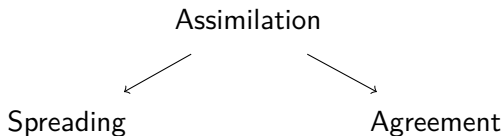\end{array}
$$

Representational Assumptions

- A well-formed AR obeys FS, the NCC, and the OCP

- Assimilation: vowels have the same feature

<div align="center">

Assimilation

Spreading   Agreement

</div>

Spreading: multiple association

+ATR

o ⟶ b → e → j → i → i

Terminology

Spreading: multiple association

$+$ATR

o $\longrightarrow$ b $\rightarrow$ e $\rightarrow$ j $\rightarrow$ i $\rightarrow$ i
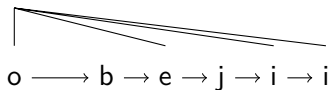
Agreement: different vowels associated to different iterations of the same feature
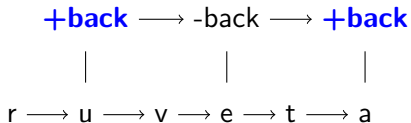
+back $\longrightarrow$ -back $\longrightarrow$ **+back**

r $\longrightarrow$ u $\longrightarrow$ v $\longrightarrow$ e $\longrightarrow$ t $\longrightarrow$ a

Forbidden Substructure Grammar

- Previous work applied logical descriptions of formal languages to phonological well formedness constraints (Heinz et al., 2011; Rogers et al., 2013)

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- Forbidden substructure grammar is a conjunction of negative literals
  - literals = substructures
  - describes a set of well-formed structures by ruling out ill formed substructures

$\neg r_1 \wedge \neg r_2 \wedge \neg r_3 \wedge \ldots \wedge \neg r_n$

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- Forbidden substructure grammar is a conjunction of negative literals
  - ▶ literals = substructures
  - ▶ describes a set of well-formed structures by ruling out ill formed substructures, r_1 through r_n

  $\neg r_1 \wedge \neg r_2 \wedge \neg r_3 \wedge \ldots \wedge \neg r_n$

- FSCs define locality because they refer to elements in a structure connected by successor or association

Neutral Vowels

Blocking Vowels: Akan

Akan ATR harmony:

- If a word contains a sequence of -low vowels they will be associated to a single ATR feature (Clements, 1976)

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- The vowels on either side of a +low vowel can be associated to different ATR features

Blocking Vowels: Akan

Table 1: Akan Vowels

	+ATR	-ATR
-low	i	ɪ
	u	ʊ
	e	ɛ
	o	ɔ
+low	ɜ	a

- -low vowels in sequence are associated to a single ATR feature: [obejii] 'he came and removed it'
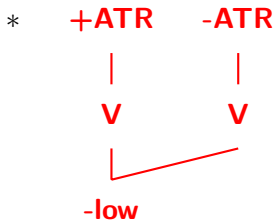
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- -low vowels on either side of a +low vowel can be associated to different ATR features: [pɪrɜko] 'pig'

Blocking Vowels: Akan

- Akan ATR harmony pattern captured by a single FSC
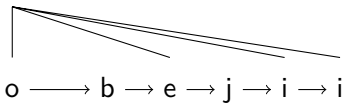 - forbids two -low vowels from being associated to different ATR features

(1)

Blocking Vowels: Akan

- Akan FSC in (1) allows grammatical spreading AR

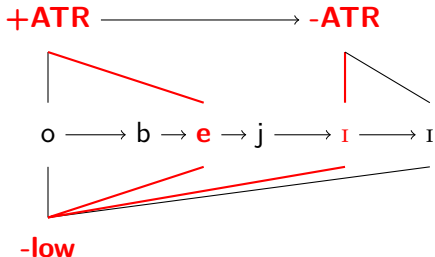 [obejii] 'he came and removed it'

+ATR

o ⟶ b → e → j → i → i

-low
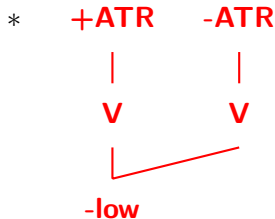
Blocking Vowels: Akan

- and (1) rules out an ungrammatical disharmonic AR because it contains the forbidden substructure

Ungrammatical Akan AR

Akan FSC

- The same FSC in (1) also allows a grammatical disharmonic AR with a +low vowel

[pɪrʒko] 'pig'
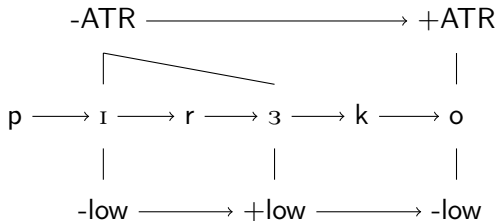
Spreading is local

Spreading ARs consist of. . .

- an unbounded span of contiguous vowels associated to a single feature

Spreading is local

Spreading ARs consist of. . .

- an unbounded span of contiguous vowels associated to a single feature
- successor relation between two different features on the same tier

Spreading is local

- **OCP makes ARs local** because different features on a tier are in successor relation regardless of how many vowels are associated to each.

[pɪrʒko] 'pig'
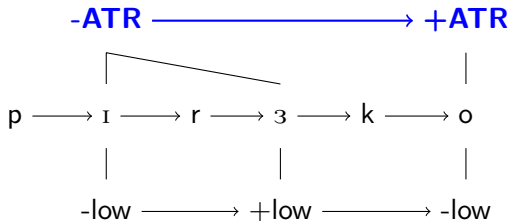
Transparent Vowels: Finnish

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- Back harmony appears to skip over [-back, -round, -low] vowels

Transparent Vowels: Finnish

Table 2: Finnish Vowels

	-round	+round		
-low	i, iː	y, yː	u, uː	
	e, eː	ø, øː	o, oː	
+low		æ, æː	ɑ, ɑː	-round
	-back		+back	

- Two harmonizing vowels in sequence are associated to a single back feature: [poutɑ] 'fine weather'

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- Harmonizing vowels on either side of a transparent vowel are associated to the same back feature: [ruvetɑ] 'start'
- The transparent vowel is associated to a different back feature **on the same tier**

Transparent Vowels: Finnish

- Set of Finnish FSCs forbid +round vowels from being associated to a -back feature that succeeds a +back feature

(2) Finnish FSCs

(a) ∗ +back → -back   (b) ∗ -back → +back
              | |
              V   V
              | |
                                         |
          +round |
                                      +round

Transparent Vowels: Finnish

- and forbid +low vowels from being associated to a -back feature that precedes a +back feature

(3)   Finnish FSCs

$$\text{(a)} \quad * \text{ +back} \rightarrow \text{-back}$$
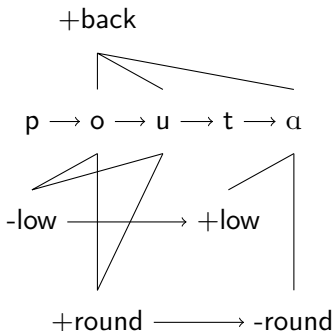
$$\text{(b)} \quad * \text{ -back} \rightarrow \text{+back}$$

Transparent Vowels: Finnish

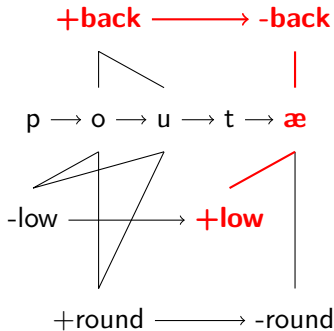- A fully harmonic word does not violate any Finnish FSCs

  [poutɑ] 'fine weather'

Transparent Vowels: Finnish

- A disharmonic word is ungrammatical because it contains the forbidden substructure of (3a)

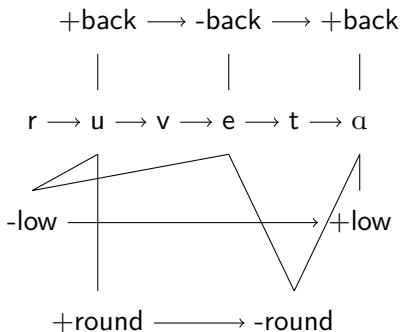Ungrammatical disharmonic word   Finnish FSC

Transparent Vowels: Finnish

- Transparent vowels [i, iː, e, eː] are associated to a feature *on each feature tier*
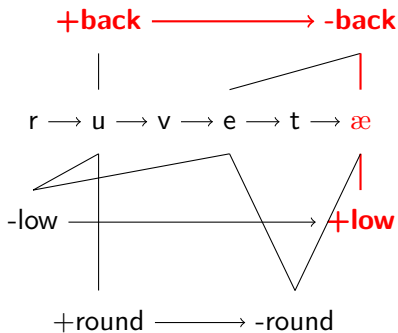
[ruvetɑ] 'start'

Transparent Vowels: Finnish

- A disharmonic word with a transparent vowel is ungrammatical because it contains the forbidden substructure of (3a)

Ungrammatical disharmonic word   Finnish FSC
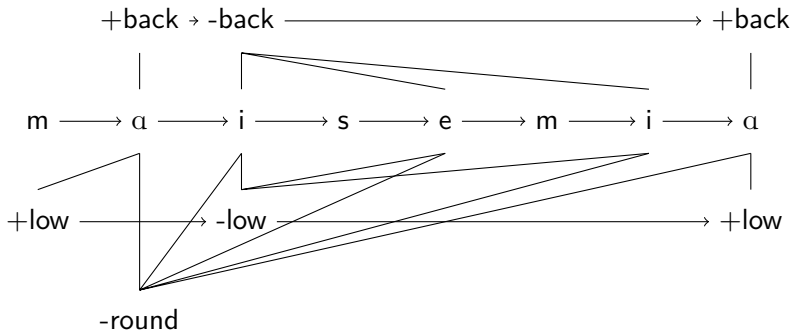
Agreement is local

Agreement ARs consist of. . .

- multiple iterations of the same feature, with a different intervening feature on the same tier

Agreement is local

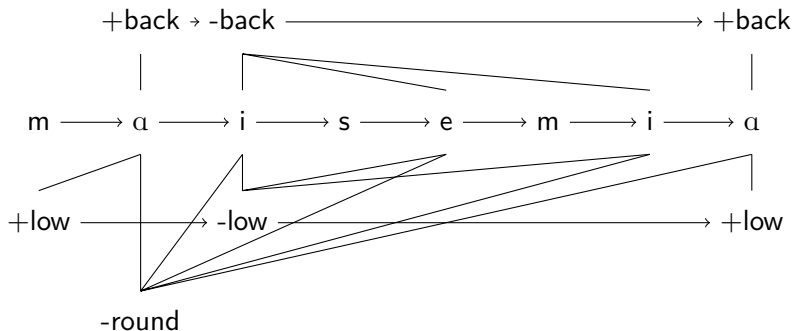- Transparent vowels associated to a feature *on each feature tier*

[mɑisemiɑ] 'scenery.plural.partitive'

Agreement is local

- Transparent vowels associated to a feature *on each feature tier*
- ARs make patterns local because of successor relation between features on each tier

[mɑisemiɑ] 'scenery.plural.partitive'

Discussion

Well-formed surface ARs of vowel harmony are local

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- ARs of vowel harmony utilize successor and association relations

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Well-formed surface ARs of vowel harmony are local

- ARs of vowel harmony utilize successor and association relations
- FSCs capture attested vowel harmony patterns that use neutral vowels: Akan, Finnish
- Transparent vowels do not require underspecification on the surface

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ARs can also represent boundaries

- FSCs can capture morphologically-conditioned harmony: morpheme boundaries on feature tiers in Turkish

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ARs can also represent boundaries

- FSCs can capture morphologically-conditioned harmony: morpheme boundaries on feature tiers in Turkish
- FSCs over multi-tiered ARs can also capture an unattested pattern: sour grapes

Future Work
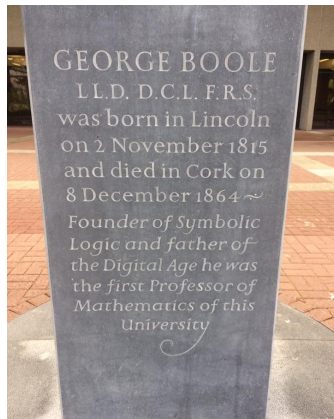
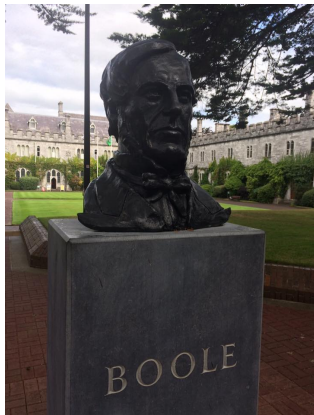- Are multi-tiered ARs too powerful?

Future Work

- Are multi-tiered ARs too powerful?
- Can multi-tiered ARs be restricted further to exclude unattested patterns?

Thank You

- QP committee: chair- Adam Jardine, Bruce Tesar, Simon Charlow
- Attendees of PhonX reading group and the 2nd Rutgers Computational Phonology Workshop

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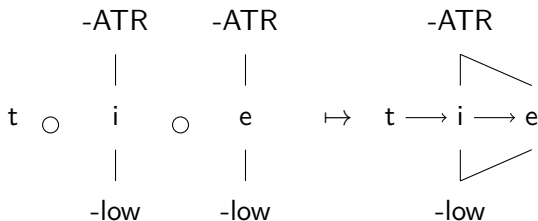
Appendix

Concatenation

- NCC and OCP derived by concatenation operation (○) (Jardine & Heinz, 2015)
  - Concatenation merges autosegmental graph primitives, like (**??**)

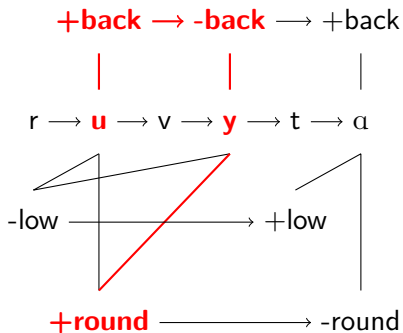(4) Concatenation of adjacent autosegmental graph primitives

- This disharmonic word with a transparent vowel is ungrammatical because it contains the forbidden structure of (2a)

Ungrammatical disharmonic word   Finnish FSC