Markedness Constraints are Negative:
An Autosegmental Constraint Definition Language

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Introduction

- The content of markedness constraints is not arbitrary (de Lacy, 2011; Rogers et al., 2013)
- Why are some logically possible constraints attested and not others?
- We present a strategy for finding a *restrictive* yet *sufficient theory* of markedness constraints

Introduction

- We argue that markedness constraints are fundamentally *negative*
- Main lesson: A better theory enriches structure rather than increasing the power of the formalism, because such a theory is *more restrictive*
- For autosegmental phonology, this means adding abstract structure indicating when units are *not* associated

Structural well-formedness

- Phonologists employ both *negative* and *positive* constraints
- OCP: “Adjacent melodic elements cannot be identical” (Leben, 1973; McCarthy, 1979)

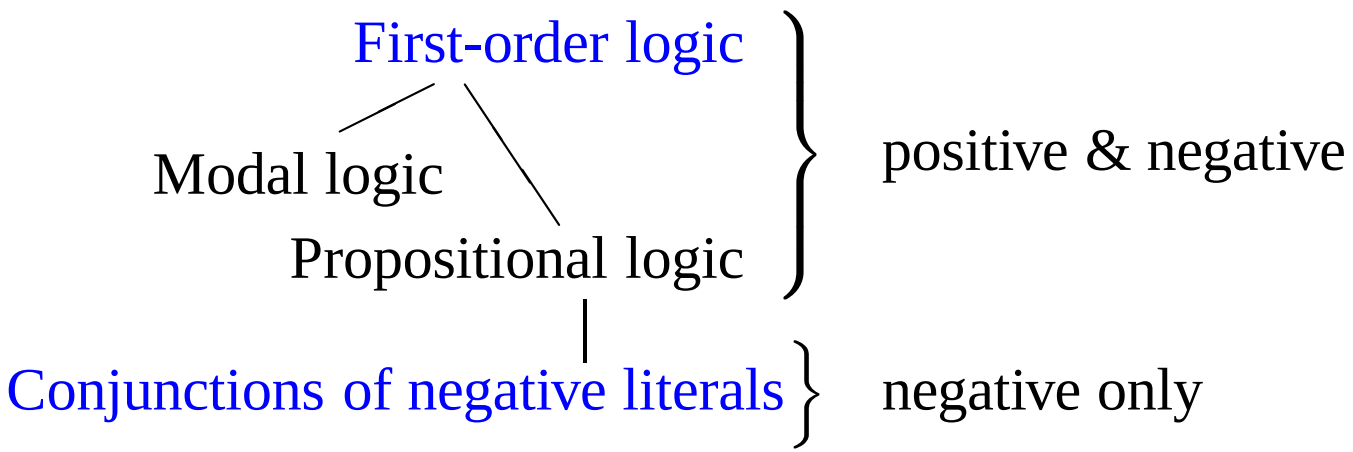
- SPEC-T: “Syllables must be specified for tone” (Meyers, 1997; Yip, 2002)

Constraint Definition Languages

- A CDL *explicitly* defines (de Lacy, 2011)
  - set of possible constraints
  - how constraints are interpreted
- Possible constraints outside CDL's range are hypothesized not to be found in natural language
- Explicit CDLs in Eisner (1997); Potts and Pullum (2002); Riggle (2004); Graf (2010); Heinz (2010)

A Logical CDL

- Statements and their interpretations are well-defined (Potts and Pullum, 2002)
- Give us a *hierarchy* of logical languages based on their restrictiveness (Rogers et al., 2013)



- Rogers et al. (2013): For phonotactics, NLs are close to enough

Two logical languages

"Nasals must be voiced"

- *Negative literals* (NLs)
  - 'Not' (¬) plus *sub*structure
  - ¬[+nasal, −voiced]
  - Interpretation: 'don't include [substructure]'
  - Fundamentally 'negative'

Two logical languages

"Nasals must be voiced"

- *Negative literals* (NLs) $\neg[+\text{nasal}, -\text{voiced}]$
- *First-order logic* (FO)
  - Quantified variables, predicates, and boolean connectives
  - $\forall x, [+\text{nasal}](x) \rightarrow [+\text{voiced}](x)$
  - Capable of making 'positive' statements

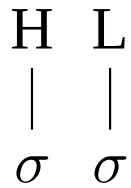
Two logical languages

"If there is a nasal, there must be a voiceless segment (somewhere in the word)"

- FO
  $\forall x, \exists y[+\text{nasal}](x) \rightarrow [-\text{voice}](y)$
- NLs
  None! (provably so)
- Rogers et al. (2013): While FO (and propositional) clearly overgenerate, most well-formedness constraints can be captured by NLs

Nonlinear structure and NLs

- Rogers et al. (2013) focused on *string* structures
- Phonologists often employ autosegmental (AP) structures (Goldsmith, 1976)



- Some common constraints over AP structures cannot be captured with NLs
  - Constraints forcing specification
  - Constraints forcing contours

Nonlinear constraints

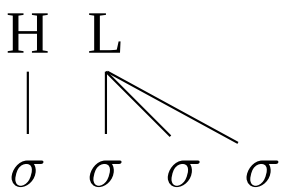
"Adjacent melodic elements can't be identical"

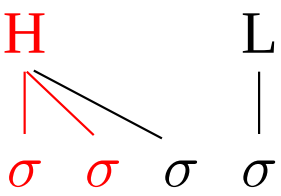
- NL: ¬HH

Nonlinear constraints

"Hs cannot be multiply associated" (Kukuya, Zoll, 2003)

- NL: ¬ 

✓ 

* 

Nonlinear constraints

“TBUs must be specified for tone”

- NL: $\neg\sigma$ (?)

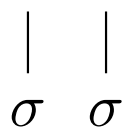
Aghem (Hyman, 2014)

- When H tone is followed by L, it spreads to the right:
  a. /é - nòm/ $\rightarrow$ [é - nôm] ‘to be hot’
  b. /fú - kìa/ $\rightarrow$ [fú - kîa] ‘your sg. rat’
  c. e-nom $\rightarrow$ e-nom [é - nôm] ‘to be hot’

  H L H L
- Constraint: “H must spread to a following L-toned TBU”

Nonlinear constraints (continued)

“H must spread to a following L-toned TBU”

- NL: ¬ 

(?)

Nonlinear structure and NLs

- How do we respond?
- Two options:
  a. Increase power of the formalism (NLs $\rightarrow$ FO)
  b. Enrich the structure (add abstract elements)
- Choice (a), as before, overgenerates
- Choice (b) gets us to the right level of expressiveness

FO and nonlinear constraints

"TBUs must be specified for tone"

- FO: $\forall x, \mathit{TBU}(x) \rightarrow (\mathit{assoc}\text{-H}(x) \vee \mathit{assoc}\text{-L}(x))$

"H must spread to a following L-toned TBU"

- FO: $\forall x, y, z, (\text{H}(x) \wedge \text{L}(y) \wedge \mathit{precedes}(x, y) \wedge \mathit{assoc}(y, z)) \rightarrow \mathit{assoc}(x, z)$

- FO generates bizarre constraints:
  $\forall w, \exists x, y, z, \mathrm{L}(w) \rightarrow \mathrm{H}(x) \wedge \mathit{assoc}(x, y) \wedge \mathit{assoc}(x, z) \wedge y \neq z$
  "If there is an L, there must also be a doubly associated H"

  $\exists x, y, z,$
  $\mathit{spec}\text{-}\mathrm{H}(x) \wedge \mathit{spec}\text{-}\mathrm{H}(y) \wedge \mathit{spec}\text{-}\mathrm{H}(y) \wedge x \neq y \neq z$
  "There must be 3 TBUs specified for H"

- This is because FO computes over *entire structure*
- NLs are fundamentally *local*

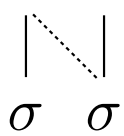
Enriching structure

“TBUs must be specified for tone”

- NL: ¬Ⓞ (Pulleyblank, 1986)

Enriching structure

“H must spread to a following L-toned TBU”

- NL: ¬ 

Anti-association lines

- Mark a *potential* association not realized
- Implied in some constraint theories:

  ∀HARMONY (Walker, 2011, 2014)

  For every feature F in a word, a violation is assigned to every vowel to which F is not associated
- Regardless, it is (provably) impossible to get constraints like FO examples, because we cannot *require* structure

Conclusions

- Negative constraints are extremely restricted; allowing positive constraints overgenerates
- Using negative constraints requires additional, abstract structure
- It is more restrictive to enrich the structure than to increase power of the formalism
- A *Representation* Definition Language is equally important as a CDL

Acknowledgements

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References I

de Lacy, P. (2011). Markedness and faithfulness constraints. In Oostendorp, M. V., Ewen, C. J., Hume, E., and Rice, K., editors, *The Blackwell Companion to Phonology*. Blackwell.

Eisner, J. (1997). Efficient generation in primitive Optimality Theory. In *Proceedings of the 35th Annual Meeting of the Association for Computational Linguistics (ACL)*, pages 313–320, Madrid.

Goldsmith, J. (1976). *Autosegmental Phonology*. PhD thesis, Massachussets Institute of Technology.

Graf, T. (2010). Comparing incomparable frameworks: A model theoretic approach to phonology. *University of Pennsylvania Working Papers in Linguistics*, 16(2):Article 10.

Heinz, J. (2010). Learning long-distance phonotactics. *Linguistic Inquiry*, 41:623–661.

Hyman, L. (2014). How autosegmental is phonology? *The Linguistic Review*, 31:363–400.

Leben, W. R. (1973). *Suprasegmental phonology*. PhD thesis, Massachussets Institute of Technology.

References II

McCarthy, J. J. (1979). *Formal Problems in Semitic Phonology and Morphology*. PhD thesis, Massachusetts Institute of Technology.

Meyers, S. (1997). OCP effects in Optimality Theory. *Natural Language & Linguistic Theory*, 15(4):847–892.

Potts, C. and Pullum, G. K. (2002). Model theory and the content of OT constraints. *Phonology*, 19:361–393.

Pulleyblank, D. (1986). *Tone in Lexical Phonology*. Dordrecht: D. Reidel.

Riggle, J. (2004). *Generation, Recognition, and Learning in Finite State Optimality Theory*. PhD thesis, UCLA.

Rogers, J., Heinz, J., Fero, M., Hurst, J., Lambert, D., and Wibel, S. (2013). Cognitive and sub-regular complexity. In *Formal Grammar*, volume 8036 of *Lecture Notes in Computer Science*, pages 90–108. Springer.

Walker, R. (2011). *Vowel patterns in language*. Cambridge: Cambridge University Press.

Walker, R. (2014). Nonlocal trigger-target relations. *Linguistic Inquiry*, 45:501–523.

Yip, M. (2002). *Tone*. Cambridge University Press.

Zoll, C. (2003). Optimal tone mapping. *LI*, 34(2):225–268.