Local faithfulness constraints over correspondence structures

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Overview

- The computationally local nature of phonological generalizations (Chandlee, 2014; Chandlee et al., 2014) can be captured through *banned substructure constraints* over *correspondence graphs* (Potts and Pullum, 2002)
  E.g. intervocalic voicing

$$\begin{array}{cccc} a & p & a & p \\ \downarrow & \downarrow & \downarrow & \downarrow \\ a & b & a & p \end{array} \qquad * \begin{array}{cccc} a & p & a & p \\ \downarrow & \downarrow & \downarrow & \downarrow \\ a & p & a & p \end{array}$$

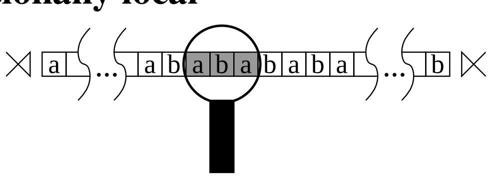
- We can constrain correspondence through *concatenation* of primitives (Jardine and Heinz, 2015)

$$\begin{array}{c} p \\ \downarrow \\ p \end{array} \quad \begin{array}{c} p \\ \downarrow \\ b \end{array} \quad * \begin{array}{c} a \\ \downarrow \\ p \end{array} \qquad * \begin{array}{cccc} a & p & a & p \\ \\ p & p & a & a \end{array}$$

- We can describe patterns without powerful LINEARITY constraints or 'counting' overgeneralization predicted by optimization
- Opens up possibilities for learning transformations

Computational locality

- Patterns describable by banning substructures that are **connected** and **bounded in size** are **computationally local**



- Locality in strings: **substrings** are substructures (Rogers and Pullum 2011; Rogers et al., 2013)
- For non-linear structures, we can extend this notion to **subgraphs** (Jardine, 2016)

The nature of correspondence

- Languages use a subset of logically possible **individual correspondences** (e.g., no a→b)

Inventory = $\{a, p, b\}$

$$C_{Sym} = \left\{ \begin{array}{c} \varnothing \\ \downarrow \\ a \end{array}, \begin{array}{c} \varnothing \\ \downarrow \\ b \end{array}, \begin{array}{c} \varnothing \\ \downarrow \\ p \end{array}, \begin{array}{c} a \\ \downarrow \\ \varnothing \end{array}, \begin{array}{c} a \\ \downarrow \\ a \end{array}, \begin{array}{c} p \\ \downarrow \\ \varnothing \end{array}, \begin{array}{c} p \\ \downarrow \\ b \end{array}, \begin{array}{c} p \\ \downarrow \\ p \end{array}, \begin{array}{c} b \\ \downarrow \\ \varnothing \end{array}, \begin{array}{c} b \\ \downarrow \\ b \end{array}, \begin{array}{c} b \\ \downarrow \\ p \end{array} \right\}$$

- **Graph concatenation** (Engelfriet and Vereijken, 1997; Jardine and Heinz, 2015) can generate **string correspondences** from C_{Sym}

$$C_{Str} = \left\{ \ldots, \begin{array}{ccccc} \# & a & p & a & \# \\ & \downarrow & \downarrow & \downarrow & \\ \# & a & p & a & \# \end{array}, \begin{array}{ccccc} \# & a & p & a & \# \\ & \downarrow & \downarrow & \downarrow & \\ \# & a & b & a & \# \end{array}, \begin{array}{ccccc} \# & a & p & a & \# \\ & \downarrow & \downarrow & \downarrow & \\ \# & \varnothing & \varnothing & \varnothing & \# \end{array}, \begin{array}{cccccc} \# & a & p & a & p & \# \\ & \downarrow & \downarrow & \downarrow & \downarrow & \\ \# & a & p & a & p & \# \end{array}, \ldots \right\}$$

- Similar to, but different from; OT's GEN
- *All* inputs are considered; input-output correspondence constrained by concatenation

Language-specific constraints

- Form of constraints: $\neg s_1 \wedge \neg s_2 \wedge \neg s_3 \wedge \ldots \wedge \neg s_n$

$$\neg \begin{array}{c} a \\ \downarrow \\ \varnothing \end{array} \wedge \neg \begin{array}{c} p \\ \downarrow \\ \varnothing \end{array} \wedge \neg \begin{array}{c} b \\ \downarrow \\ \varnothing \end{array} (=\text{MAX}) \quad * \begin{array}{ccccc} \# & a & p & a & \# \\ & \downarrow & \downarrow & \downarrow & \\ \# & a & \varnothing & a & \# \end{array} \quad \begin{array}{ccccc} \# & a & p & a & \# \\ & \downarrow & \downarrow & \downarrow & \\ \# & a & p & a & \# \end{array}$$

$$*\text{apa} = \neg \begin{array}{ccc} & p & \\ & \downarrow & \\ a & p & a \end{array} \quad \begin{array}{cccccc} \# & a & p & a & p & \# \\ & \downarrow & \downarrow & \downarrow & \downarrow & \\ \# & a & b & a & p & \# \end{array} \quad * \begin{array}{cccccc} \# & a & p & a & p & \# \\ & \downarrow & \downarrow & \downarrow & \downarrow & \\ \# & a & p & a & p & \# \end{array}$$

- Constraints interact through *conjunction* ($\wedge$):

*apa ∧ MAX ∧ DEP

- Surface *apa sequences repaired through voicing

Constraints (cont'd)

- We also need to forbid *over*-repairing

$$* \begin{array}{ccccc} \# & p & a & p & \# \\ & \downarrow & \downarrow & \downarrow & \\ \# & b & a & b & \# \end{array} \quad * \begin{array}{ccccccc} \# & p & a & p & p & a & \# \\ & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \\ \# & p & a & b & p & a & \# \end{array} \quad * \begin{array}{ccccccc} \# & p & a & b & p & a & \# \\ & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \\ \# & p & a & b & b & a & \# \end{array}$$

- $\text{NoCCVoi} = \neg \begin{array}{cc} p & \\ \downarrow & \\ p & b \end{array} \wedge \neg \begin{array}{cc} & p \\ & \downarrow \\ b & p \end{array} \wedge \neg \begin{array}{cc} & p \\ & \downarrow \\ b & b \end{array} \wedge \neg \begin{array}{cc} p & \\ \downarrow & \\ b & b \end{array}$

Final grammar: *apa ∧ MAX ∧ DEP ∧ NOCCVOI ∧ NOINITVOI ∧ NOFINVOI

Discussion/Conclusions

- Captures the **local** nature of correspondence and faithfulness
- Cannot capture 'counting' patterns overgenerated by optimization (Gerdemann and Hulden, 2012, Lombardi 1999; Baković 2000;)
- A local learning model can 'scan' through input

$$\begin{array}{cccccc} \# & a & p & a & p & \# \\ & \downarrow & \downarrow & \downarrow & \downarrow & \\ \# & a & b & a & p & \# \end{array} \quad \begin{array}{cccccc} \# & a & p & a & p & \# \\ & \downarrow & \downarrow & \downarrow & \downarrow & \\ \# & a & b & a & p & \# \end{array} \quad \begin{array}{cccccc} \# & a & p & a & p & \# \\ & \downarrow & \downarrow & \downarrow & \downarrow & \\ \# & a & b & a & p & \# \end{array} \quad \begin{array}{cccccc} \# & a & p & a & p & \# \\ & \downarrow & \downarrow & \downarrow & \downarrow & \\ \# & a & b & a & p & \# \end{array}$$

Acknowledgements & Select References

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