Finite-State Optimality Theory and a Theory of Vowel Harmony

One of the major challenges to Optimality Theory (OT) (Prince & Smolensky, 1993/2004) as a theory of cross-linguistic typology is that many of the predicted languages can never occur in natural language. This paper argues that finite-state technology is advantageous in understanding, evaluating and improving theories of phonological processes. Specifically, this paper presents an investigation of a theory of vowel harmony formalized in finite-state OT. The Contenders Algorithm (Riggle, 2004) and a program (Riggle, personal communication) based on sing Elementary Ranking Conditions (ERC’s) (Prince, 2002), are used to compute an attested factorial typology of vowel harmony interactions.

Computational methods are the most comprehensive method for understanding the formal and typological consequences of an analysis. Tools such finite-state OT, which convert the representations of GEN and all proposed constraints into a formalized version of the grammar, allow the researcher to avoid overlooking pathological predictions, and can be used to inform the researcher of any novel pathologies predicted after a revision of the theory. Formalizing an OT analysis in terms of finite-state machines (i) forces the analyst to be formally precise about the assumptions of the theory and its representations and (ii) makes it possible to evaluate a large number of inputs and candidates that would be too unwieldy to accomplish by hand. Finite-state machines are also compatible with the Contenders Algorithm (Riggle, 2004), which uses a shortest-best-path model to search for all possible winning candidates. The output of this computation can be fed into a program based on ERC’s to produce and evaluate a factorial typology of all predicted languages (Riggle, personal communication).

These methods were used to test the hypothesis that a constrained theory of linguistic typology arises through enriching phonological representations. While such enrichment may appear counter-intuitive, enriched representations provide the analyst greater control of a theory of optimal phonological systems. Turbid Spreading, a theory of representations for vowel harmony, enriches the representations for vowel harmony using a covert, abstract level of representation to induce local vowel agreement (Goldrick, 2001) (Example 1). The three layers of representation: underlying form, phonological (licensing) level and pronunciation (surface) level are encoded into triples (UR: PR: SR) within the formal architecture of finite state machines. Restrictions on the relationship between these three levels were encoded in GEN, and spreading was induced by a specially formulated SPREAD constraint to encode spreading using the abstract level of representation. A factorial typology for Turbid Spreading was creating using the Contenders Algorithms and the ERC’s program from a set of over 300 inputs.

The computation produced a typology of 16 languages, all naturally occurring: 4 non-harmony languages, 6 right-to-left harmony languages, and 6 left-to-right harmony languages. The non-harmony languages contained one allowing the marked segment, and three disallowing such vowels, two with covert spreading to underlyingly marked vowels (one left-to-right, one right-to-left), and one with no covert spreading. The right-to-left harmony languages included one with no harmony blockers (Kalenjin), one with marked vowels that occur only as a result of spreading (Pasiego), one with opaque vowels (Akan), one with bi-directional harmony, but with left-to-right spreading as default (Lango), and two transparent languages, each with different representations of underlyingly marked vowels (Hungarian). The six left-to-right languages were analogous to the right-to-left languages. These results were extended further to include epenthetic vowels, which provide a similarly positive result, supporting an approach to phonological analysis in OT that makes use of explicit representations of phonological structure combined with computational tools for exploring potential candidates and typologies.
(1) Representation of Vowel Harmony in Turbid Spreading (Transparent Vowel)

/ [+ATR]  [–ATR]  [–ATR]/  Underlying Representation

\[ +ATR \]  \[+ATR\] \[+ATR\]  Phonological Level

\[ +ATR \]  \[–ATR\] \[–ATR\]  Pronunciation/Surface Level

References:


