Deriving Economy Principles in OT-Morphology

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THE PROBLEM

An Example From Georgian

(1) *xedav-en*
see-S3pl
'they see'

Redundant Candidates:

xedav-en, xedav-en-en, xedav-en-en, xedav-en-en-en ...

NON-REDUNDANCY BY STIPULATION

Non-Redundancy-Principle: The output information [of an inflectional affix] must not be contained in the input. (Wunderlich and Fabri, 1994:262)

Economy: The fewer affixes the better (Noyer, 1993:19)

MOTIVATION FOR DERIVING NON-REDUNDANCY

- Occam's Razor: Non-Redundancy as a theorem is more parsimonious than Non-Redundancy as an axiom.
- A violable Non-Redundancy constraint will not guarantee Non-Redundancy if it is not dominant in the constraint ranking.

THE BASIC IDEA

➤ No constraint type ever favors Redundancy for any input.

➤ Edge Alignment Constraints disfavor Redundancy, since it increases the distance of morphemes from edges.

⇒ For each redundant candidate, there is a more harmonic candidate that is not redundant.

⇒ Redundant forms are never optimal.

ALIGNMENT CONSTRAINTS

	NUM ➪ R	L ⇦ PER
xedav		
xedav-en		*
xedav-en-en	*	**
xedav-en-en-en	**	***
xedav-en-en-en-en	***	****

OTHER CONSTRAINTS

	PARSE PER	PARSE NUM
xedav	*	*
xedav-en		
xedav-en-en		
xedav-en-en-en		
xedav-en-en-en-en		

Overview

- The Basic Idea
- The Framework
- Proving Non-Redundancy
- Summary and Prospects

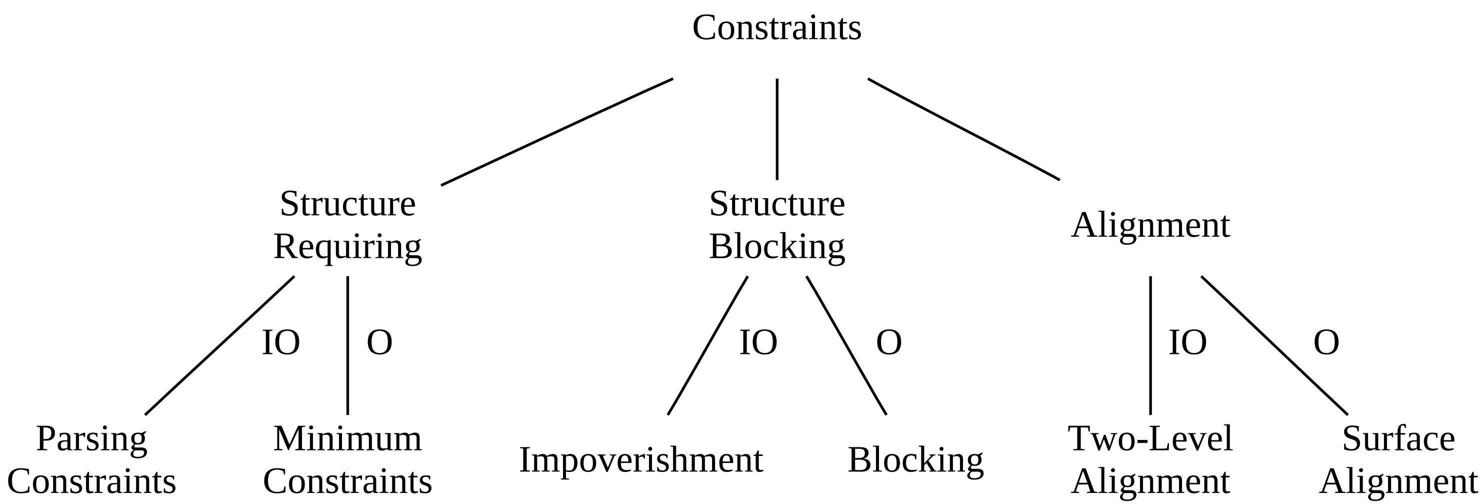
Input

$$[+V]_1 \begin{bmatrix} +tense \\ +pres \end{bmatrix}_2 \begin{bmatrix} +Agr \\ +3 \\ -1 \\ +pl \end{bmatrix}_3$$

Output

$$xedav \leftrightarrow [+V]_1 \qquad en \leftrightarrow \begin{bmatrix} +Agr \\ +3 \\ +pl \end{bmatrix}_3$$

Constraint Types



- Fidelity: VIs have only one index.
- Coherence: Adjacent VIs have identical Indeces.
- Context Maximization: VIs with Context Specifications are preferred
- Reflect: Morphologically adjoined heads reflect the position of their syntactic host.

MINIMUM CONSTRAINTS

Classical Nahuatl

no-cal	*cal-tin*	*no-cal-huan*	*cal-li/*cal*
my-house	house-pl	my-house-pl	house-abs
‘my house’	‘houses’	‘my houses’	‘house’

Minimum FS**:** Count a constraint violation if the output string contains no VI with a feature structure subsumed by FS.

BLOCKING CONSTRAINTS

(1) **Georgian**

a. *v-xedav* 'I see'
[+1+Nom]-see

b. *g-xedav-s* 'he sees you (sg.)'
[+2+Acc]-see-[+3+Nom+sg]

c. *g-xedav/*v-g-xedav* 'I see you (sg.)'
[+2+Acc]-see

Block *Descr*: Count a constraint violation if there is more than one VI in the output of the type specified by *Descr*.

PARSE CONSTRAINTS

Input:[+1+Nom][+2+Acc]	BLOCK Prefix	PARSE Acc	PARSE Nom
xedav		*!	*
v-xedav		*!	
v-g-xedav	*!		
☞ *g-xedav*			*

Parse FS **:** Count a constraint violation for each feature structure FS' in the input that is subsumed by FS and not realized by a feature structure in the output that parses FS in FS'.

ALIGNMENT CONSTRAINTS

v-xedav	*v-xedav-t*	*xedav-s*	*xedav-en*
S1-see	S1-see-PL	see-S3s	see-S3p
'I see'	'we see'	'he sees'	'they see'

Align *Descr*: Count a constraint violation for each VI that intervenes between the designated edge of the spell-out domain and a VI of the type specified by *Descr*.

(1) a. [+NUM] ⇨ R
b. L ⇦ [+PER]

REFLECT CONSTRAINTS

REFLECT FS **:** For all input feature structures F_1 that are right-adjacent to another feature structure F_0, and subsumed by FS, where both F_1 and F_0 have correspondent VIs in $Cand$: Count a constraint violation if $Cand$ is not of the form $V^* \; V_0{}^* \; V_{0/1}{}^* \; V_1{}^* \; V^*$.

(1) a. *xedavd -n -en* 'they saw'
see$_1$ [+past]$_2$ [+3+pl]$_3$

b. *xedavd -a* 'he saw'
see$_1$ [+past]$_2$ [+3+sg]$_3$

DEFINITION OF NON-REDUNDANCY

A word form is non-redundant iff it does not contain two instances of the same vocabulary items with the same index set.

CLAIM

All word forms are non-redundant under all possible rankings.

The Proof (I)

- For each candidate $Cand^*$ that violates Non-Redundancy, there is a sequence $Cand_0\ Cand_1 \ldots Cand_n\ Cand^*$ ($Cand^* = Cand_{n+1}$) such that $Cand_{i+1}$ is the result of inserting one more instance of a VI from $Cand_i$ into $Cand_i$ ($0 \leq i \leq n$), and $Cand_0$ is non-redundant.
- Assume that $Cand_{i+1}$ is less harmonic than $Cand_i$ for all $i, 0 \leq i \leq n$ under all possible rankings of all possible constraints.

⇒ By the transitivity of harmony it follows that $Cand^*$ is always less harmonic than $Cand_0$.

$Cand_i$ and $Cand_{i+1}$

$$Cand_i = V_1 \ldots V_p V_{p+1} \ldots V_m$$

$$Cand_{i+1} = W_1 \ldots W_p X W_{p+1} \ldots W_m$$

$$W_j = V_j, 0 \leq j \leq m$$

Proof (II)

- **For all possible constraints:**
  $Cand_i$ is at least as harmonic as $Cand_{i+1}$.
- **For at least one constraint:**
  $Cand_i$ is more harmonic than $Cand_{i+1}$.

$\Rightarrow$ $Cand_i$ is always more harmonic than $Cand_{i+1}$.

MINIMUM CONSTRAINTS

If $Cand_i$ violates MINIMUM FS

⇒ no VI in $Cand_i$ fulfills the description of FS.

$Cand_{i+1}$ consists only from the VIs from $Cand_i$.

⇒ $Cand_{i+1}$ also violates MINIMUM FS.

If $Cand_i$ does not violate MINIMUM FS

⇒ $Cand_{i+1}$ cannot be more harmonic than a candidate which does not violate the constraint.

BLOCKING CONSTRAINTS

If $Cand_i$ violates BLOCK FS

⇒ there must be at least two VI instances in $Cand$ meeting FS.

For every distinct VI instance in $Cand_i$ (V_j),
there is a distinct instance of the same VI in $Cand_{i+1}$ (W_j).

⇒ $Cand_{i+1}$ also contains two VI instances meeting FS.

If $Cand_i$ does not violate BLOCK FS

⇒ $Cand_{i+1}$ cannot be more harmonic for BLOCK FS than a candidate which does not violate the constraint.

ALIGNMENT CONSTRAINTS

- ➤ Each violation of an alignment constraint A is induced by a VI instance V_p between a designated edge E and some VI instance V_q of a designated type.
- ➤ If a distinct pair $< V_p, V_q >$ occurs in $Cand_i$ in a given order, a distinct pair $< W_p, W_q >$ will do so in $Cand_{i+1}$.

$\Rightarrow$ For each violation induced by $Cand_i$ there is a corresponding violation induced by $Cand_{i+1}$.

REFLECT CONSTRAINTS

Assumption: For some input feature structure, $Cand_{i+1}$ does not violate REFL.

$\Rightarrow Cand_{i+1}$ is an instance of $V^* \; {V_0}^* \; {V_{0/1}}^* \; {V_1}^* \; V^*$:
$V^a \; {V_0}^b \; {V_{0/1}}^c \; {V_1}^d \; V^e$ (a, b, c, d, e natural numbers).

⇒ $Cand_i$ correspond to one of the following patterns:

a. $V^{\mathbf{a-1}}\ {V_0}^b\ {V_{0/1}}^c\ {V_1}^d\ V^e$
b. $V^a\ {V_0}^{\mathbf{b-1}}\ {V_{0/1}}^c\ {V_1}^d\ V^e$
c. $V^a\ {V_0}^b\ {V_{0/1}}^{\mathbf{c-1}}\ {V_1}^d\ V^e$
d. $V^a\ {V_0}^b\ {V_{0/1}}^c\ {V_1}^{\mathbf{d-1}}\ V^e$
e. $V^a\ {V_0}^b\ {V_{0/1}}^c\ {V_1}^d\ V^{\mathbf{e-1}}$

All of these patterns again instantiate $V^*\ {V_0}^*\ {V_{0/1}}^*\ {V_1}^*\ V^*$

⇒ If $Cand_{i+1}$ does not violate REFL, neither does $Cand_i$.

Deriving that $Cand_i \gg Cand_{i+1}$

Assumption: Each VI in the Vocabulary is subject to at least one Alignment constraint

Theorem: $Cand_{i+1}$ is less harmonic than $Cand_i$ for at least one Alignment constraint.

$\Rightarrow Cand_{i+1}$ is less harmonic than $Cand_i$.

$Cand_i$ and $Cand_{i+1}$

$$Cand_i = V_1 \ldots V_p V_{p+1} \ldots V_m$$

$$Cand_{i+1} = W_1 \ldots W_p X_{i+1} W_{p+1} \ldots W_m$$

$$W_j = V_j, 0 \leq j \leq m,$$

$$X_i \in \{V_1 \ldots V_m\}$$

Proof (I)

By assumption there must be an alignment constraint $Cons$ aligning X_{i+1} to the left or right edge of $Cand_{i+1}$ and a second instance X_i of the VI instantiated by X_{i+1}.

For each item in $Cand_i$ that induces a violation of an alignment constraint A (V_j), there is a corresponding item in $Cand_{i+1}$ (W_j) that does the same. An item in $Cand_{i+1}$ that violates A while its correspondent in $Cand_i$ does not, or which has no correspondent in $Cand_i$ suffices to show that $Cand_i$ is more harmonic for A than $Cand_{i+1}$.

If X_{i+1} is closer to the designated edge of A than X_i

(1) a. **EDGE** $\ldots X_{i+1} \ldots X_i \ldots$
b. $\ldots X_i \ldots X_{i+1} \ldots$ **EDGE**

➤ X_{i+1} induces a violation of A.

➤ X_{i+1} corresponds to no vocabulary item from $Cand_i$.

⇒ $Cand_{i+1}$ induces at least one more violations of A than $Cand_i$.

If X_i is closer to the designated edge

There are three possible cases.

(1) a. **EDGE** … **X** … X_i … X_{i+1} …
b. **EDGE** … X_i … **X** … X_{i+1} …
c. **EDGE** … X_i … X_{i+1} … **X** …

a. All further VI instances aligned by *Cons* are on the left of X_i:
⇒ X_i induces an additional constraint violation.

b. All further VI instances aligned by *Cons* are on the left of X_{i+1}:
⇒ The rightmost VI of **X** induces an additional constraint violation.

c. There are items aligned by *Cons* on the right of X_{i+1}
⇒ X_{i+1} induces an additional constraint violation of *Cons*.

Summary and Prospects

- ➤ Non-Redundancy follows from plausible assumptions about the Constraint Inventory.
- ➤ This can be proved given explicit statements about the formal format of Constraints.
- ➤ Empirical Motivation for the Assumed Constraint Types (Trommer, 2002)
- ➤ Analogue Proofs for other Aspects of Economy

References

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