Scalar Positional Markedness and Faithfulness in Harmonic Grammar

Brian Hsu and Karen Jesney
University of Southern California
hsub@usc.edu; jesney@usc.edu

CLS 51 • April 23-25, 2015

1. Introduction

Languages show various types of sensitivity to the edges of prosodic domains. Two types of pattern (Flack 2009):
• ‘Superset at edge’ → A marked structure is permitted at prosodic boundaries of strength x or greater, but is banned elsewhere.
• ‘Subset at edge’ → A marked structure is banned at prosodic boundaries of strength x or greater, but is permitted elsewhere.

Capturing these patterns in Optimality Theory (Prince & Smolensky 1993/2004) presents challenges:
• Scalar constraints – like HNUC – cannot capture implicational patterns of repair vs. non-repair.
• Positional constraints indexed to prosodic boundaries allow non-implicational or ‘level-skipping’ patterns.

Claim: If constraints are weighted as in Harmonic Grammar (HG; Legendre, Miyata & Smolensky 1990, Smolensky & Legendre 2006; see also Goldsmith 2003), scalar constraints can be successfully applied to this problem.
• Patterns of repair vs. non-repair are captured.
• An appropriately restrictive typology is generated.

Structure of the talk:
§2 Edge-based asymmetries in OT
§3 The overgeneration problem in OT
§4 Scaling constraints in Harmonic Grammar
§5 Comparing OT and HG typologies
§6 Conclusion

2. Edge-based asymmetries in OT

With syllable structure constraints, two types of positional asymmetries arise at prosodic boundaries: 'superset-at-edge' patterns and 'subset-at-edge' patterns (Flack 2009).

In ‘superset-at-edge’ patterns, more marked structures are permitted at more prominent boundaries.


/i-N-koma-i/ → pWd[iŋ.ko.ma.ti] ‘he will paddle’
/i-N-koma-aa-i/ → pWd[iŋ.ko.ma.ŋaa.ti] ‘he will paddle again’

Such patterns can be modeled in OT using positional faithfulness constraints (Beckman 1998, Casali 1996) that favor prominent positions.

(2) a. [DEP-INIT – Assign a violation mark to any output segment in initial position of a syllable that lacks an input correspondent.

b. pWd[DEP-INIT – Assign a violation mark to any output segment in initial position of a prosodic word that lacks an input correspondent.
(3) **Only word-initial syllables can be onsetless:** \( \text{pw}_{\text{D}} \text{EP-\text{INIT}} \gg \text{ONSET} \gg \sigma_{\text{DEP-\text{INIT}}} \)

<table>
<thead>
<tr>
<th>/i-N-koma-i/</th>
<th>( \text{pw}_{\text{D}} \text{EP-\text{INIT}} )</th>
<th>( \text{ONSET} )</th>
<th>( \sigma_{\text{DEP-\text{INIT}}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{pw}_{\text{D}}[\text{iN.ko.ma.i}] )</td>
<td>( *! )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{pw}_{\text{D}}[\text{iN.ko.ma.tj}] )</td>
<td>( * )</td>
<td>( * )</td>
<td></td>
</tr>
<tr>
<td>( \text{pw}_{\text{D}}[\text{tiN.ko.ma.tj}] )</td>
<td>( *! )</td>
<td>( * )</td>
<td></td>
</tr>
<tr>
<td>( \text{pw}_{\text{D}}[\text{tiN.ko.ma.tj}] )</td>
<td>( *! )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In ‘subset-at-edge’ patterns, fewer marked structures are permitted at more prominent boundaries.

(4) Guhang Ifugao (Newell 1956, Smith 2002) tolerates onsetless syllables word-medially, but requires onsets in word-initial syllables.

*Medial onsetless syllables* \( \text{(Newell 1956:535, 538)} \)  
- \( \text{bū.un} \) ‘an Ifugao necklace’  
- \( \text{ma.ŋá.an} \) ‘remove’  
- \( \text{ha.í.tan} \) ‘whetstone’

*Word-initial syllables must have onsets* \( \text{(Newell 1956: 534-6)} \)  
- \( \text{bú.uŋ ‘an Ifugao necklace’} \)  
- \( \text{ma.ŋá.an ‘remove’} \)  
- \( \text{ha.í.tan ‘whetstone’} \)

These patterns are captured in OT by **positional markedness constraints** indexed to prosodically prominent positions (Smith 2002, Flack 2009).

(5)  
- a. *\( \sigma_{\text{V}} \) – Assign a violation mark to any vowel that is initial in a syllable.  
- b. *\( \text{pw}_{\text{D}} \text{V} \) – Assign a violation mark to any vowel that is initial in a PWd.

(6) **Only word-initial syllables require onsets:** *\( \text{pw}_{\text{D}} \text{V} \gg \text{DEP} \gg \sigma_{\text{V}} \)

<table>
<thead>
<tr>
<th>/a.i.tan/</th>
<th>*( \text{pw}_{\text{D}} \text{V} )</th>
<th>( \text{DEP} )</th>
<th>*( \sigma_{\text{V}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{pw}_{\text{D}}[\text{a.i.tan}] )</td>
<td>( *! )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{pw}_{\text{D}}[\text{a.hi.tan}] )</td>
<td>( *! )</td>
<td>( * )</td>
<td></td>
</tr>
<tr>
<td>( \text{pw}_{\text{D}}[\text{ha.i.tan}] )</td>
<td>( * )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{pw}_{\text{D}}[\text{ha.hi.tan}] )</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Languages may also impose 'cutoffs' for positional repair at phrase and utterance edges (Flack 2009).

(7) Leti (Hume 1998: 163) permits syllable-final and word-final codas, but bans them phrase-finally. Phrase-final codas are repaired by metathesis with a preceding vowel.

\( /...\text{urun}/ \rightarrow [...\text{urun}]_{\text{Ph}} \quad \) ‘beautiful’

\( /...\text{urun mɔa}/ \rightarrow [...\text{urun mɔa}]_{\text{Ph}} \quad \) ‘Moanese breadfruit’

\( /...\text{məsar}/ \rightarrow [...\text{mesər}]_{\text{Ph}} \quad \) ‘teacher’

\( /...\text{məsar lavna}/ \rightarrow [...\text{mesər lavna}]_{\text{Ph}} \quad \) ‘teacher, big’

(8) Selayarese (Mithun & Basri 1986: 242) allows onsetless syllables everywhere except at the beginning of an utterance; underlying onsetless syllables in utterance-initial position undergo glottal stop epenthesis.

\( \text{Utt}[\text{ʔa:pa}] \quad \) ‘what?’

\( \text{Utt}[\text{ʔi:nŋi}] \quad \) ‘this’

\( \text{Utt}[\text{ʔa:pa ‘i:nŋi}] \quad \) ‘what is this?’

Accounting for the full range of asymmetries patterns in OT requires a proliferation of **positional faithfulness and positional markedness constraints**, corresponding to each level of the prosodic hierarchy.

---

3. The overgeneration problem in OT

The interaction of positional markedness and positional faithfulness in OT predicts **unattested 'level-skipping' patterns**.
Marked elements are permitted at one level of prosodic structure even while the same element is prohibited at both higher and lower levels (and vice versa).

(9) a. PPh ...initial V not allowed 
   | PWd ...initial V allowed 
   | σ ...initial V not allowed 
   b. PPh ...initial V allowed 
   | PWd ...initial V not allowed 
   | σ ...initial V allowed 

Unattested language 1: PWd-medial syllables and PPh-initial syllables must have onsets, but PWd-initial syllables in phrase-medial position can be onsetless.

- Problematic ranking: *pph[V >> pph][DEP-PHINIT, pWd][DEP-PHINIT] >> *pWd[V, *a][DEP-PHINIT]
- Breaking down the rankings:
  - PPh edge ranking: *pph[V >> pph][DEP-PHINIT] (M >> F)
  - PWd edge ranking: pWd[DEP-PHINIT] >> *pWd[V] (F >> M)
  - Syllable onset ranking: *a[V >> a][DEP-PHINIT] (M >> F)

Unattested language 2: PPh-initial and PWd-medial syllables can be onsetless, but PPh-medial, PWd-initial syllables must have onsets.

- Breaking down the rankings:
  - PPh edge ranking: pph[DEP-PHINIT] >> *pph[V] (F >> M)
  - PWd edge ranking: *pWd[V >> pWd][DEP-PHINIT] (M >> F)
  - Syllable onset ranking: *a[DEP-PHINIT] >> *a[V] (F >> M)

(10) a. Phrase-initial and PWd-medial syllables must have onsets

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>pWd[V, V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pWd[V, CV]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pWd[CV, CV]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. Phrase-medial, PWd-initial syllables can be onsetless

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>…pWd[V, V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>…pWd[V, CV]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>…pWd[CV, CV]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(11) a. Phrase-initial and PWd-medial syllables can be onsetless

<table>
<thead>
<tr>
<th>/VV/</th>
<th>*pph[V]</th>
<th>*pWd[V]</th>
<th>a[DEP-PHINIT]</th>
<th>*a[V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>pWd[V, V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>pWd[V, CV]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pWd[CV, CV]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. Phrase-medial, PWd-initial syllables must have onsets

<table>
<thead>
<tr>
<th>/…VCV/</th>
<th>*pph[V]</th>
<th>*pWd[V]</th>
<th>a[DEP-PHINIT]</th>
<th>*a[V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>…pWd[V, V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>…pWd[V, CV]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pph[</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>…pWd[CV, CV]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Separate **fixed rankings** among faithfulness constraints and among markedness constraints cannot resolve this issue.

- The examples in (10) and (11) are consistent with strict rankings where:
  \[ \text{PPH[DEP-INIT]} \gg \text{PWD[DEP-INIT]} \gg \text{σ[DEP-INIT]} \quad \text{and} \quad *\text{PPH}[V] \gg *\text{PWD}[V] \gg *\text{σ}[V] \]

**Stringently-defined constraints** (de Lacy 2002) also cannot resolve this issue.

- Stringently-defined faithfulness constraints:  \(\geq\text{PPH[DEP-INIT]}\),  \(\geq\text{PWD[DEP-INIT]}\),  \(\geq\text{σ[DEP-INIT]}\)
- Stringently-defined markedness constraints:  \(*\geq\text{PPH}[V]\),  \(*\geq\text{PWD}[V]\),  \(*\geq\text{σ}[V]\)

(12) **a. Phrase-initial and PWd-medial syllables must have onsets ... stringency version**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PPH[PWD[V.V]]</td>
<td>!</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>PPH[PWD[V.CV]]</td>
<td>!</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>PPH[PWD[V.CV]]</td>
<td>!</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>*≥PPH[PWD[V.CV]]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

**b. Phrase-medial, PWd-initial syllables can be onsetless ... stringency version**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PPH[...PWD[V.V]]</td>
<td>!</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>*≥PPH[...PWD[V.CV]]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>PPH[...PWD[V.CV]]</td>
<td>!</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>PPH[...PWD[V.CV]]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

### 4. Scaling constraints in Harmonic Grammar

In Harmonic Grammar (Legendre, Miyata & Smolensky 1990, Smolensky & Legendre 2006), constraints are **weighted** rather than ranked.

- **Consequence:** Regardless of their “basic” weight / ranking, they can influence which candidates are selected as optimal.


/\text{i}-N-koma-i/ \(\rightarrow [\text{i}N\text{ko.mai.ti}]\) 'he will paddle'

/\text{i}-N-koma-aa-i/ \(\rightarrow [\text{i}N\text{ko.maa.tii}]\) 'he will paddle again'

To illustrate with indexed constraints in HG, only PWd-initial syllables will be onsetless provided that the following weighting conditions hold:

- \(w(\text{ONSET}) > w(\text{σ}[\text{DEP-INIT}])\)
- \(w(\text{σ}[\text{DEP-INIT}]) + w(\text{PWD}[\text{DEP-INIT}]) > w(\text{ONSET})\)

(14) **Only PWd-initial syllables can be onsetless**

<table>
<thead>
<tr>
<th>/i-N-koma-i/</th>
<th>ONSET (w = 3)</th>
<th>PWd[DEP-INIT] (w = 2)</th>
<th>σ[DEP-INIT] (w = 2)</th>
<th>(H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWd[iN.ko.ma.i]</td>
<td>-2</td>
<td>-1</td>
<td>-1</td>
<td>-6</td>
</tr>
<tr>
<td>*PWD[iN.ko.ma.ti]</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>-5</td>
</tr>
<tr>
<td>PWd[iN.ko.ma.i]</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>-7</td>
</tr>
<tr>
<td>PWd[iN.ko.ma.ti]</td>
<td>-1</td>
<td>-2</td>
<td>-2</td>
<td>-6</td>
</tr>
</tbody>
</table>

**But:** Indexed constraints in HG also overgenerate. Level-skipping patterns are wrongly predicted.
Proposal: There are no distinct positional constraints in HG. Instead, constraint violations are scaled to the prominence of the edge at which they occur.

Some previous uses of weighted scalar constraints:
- Kimper (2011) – scaling based on locality and properties of triggers / targets in vowel harmony
- Pater (2012) – scaling based on nucleic sonority to model Berber syllabification
- Pater (to appear) – scaling based on weight and sonority to model compatibility with stress
- Coetzee & Kawahara (2013) – scaling based on lexical frequency
- Jesney (2014) – scaling based on sonority cline to model syllable contact effects

Here: Scaling based on the strength of the associated prosodic boundary

(15) Scaled $d[D[DEP-INIT]$  
Given a basic constraint weight $w$,  
a scale $D = \{0, 1, \ldots, n\}$ corresponding to some dimension of prominence,  
and a scaling factor $s$,  
For any output segment in the initial position of some domain $d \in D$ that lacks an input correspondent,  
Assign a weighted violation score of $w + s(d)$

Example: Weight $w = 2$  
Prominence scale = {Syllable, PWd, PPh, Utterance}  
Scaling factor $s = 2$  
epentheses at a syllable boundary: $d[D[DEP-INIT$ violation of $w + s$(Syllable) = $2 + 2(0) = 2$  
epenthesis at a word boundary: $d[D[DEP-INIT$ violation of $w + s$(PWd) = $2 + 2(1) = 4$

(16) PWd-initial syllables can be onsetless, not word-medial syllables

<table>
<thead>
<tr>
<th>/i/-N-koma/-i/</th>
<th>ONSET $w = 3$</th>
<th>d[D[DEP-INIT $w = 2, s = 2$</th>
<th>$H$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{pw}_{\text{d}}[\text{i}/\text{n}.\text{k}/\text{o}.\text{ma}.\text{i}]$</td>
<td>$-2$</td>
<td>$-6$</td>
<td></td>
</tr>
<tr>
<td>$\text{pw}_{\text{d}}[\text{i}/\text{n}.\text{k}/\text{o}.\text{ma}.\text{i}]$</td>
<td>$-1$</td>
<td>$-1_{\sigma}$</td>
<td>$-5$</td>
</tr>
<tr>
<td>$\text{pw}_{\text{d}}[\text{i}/\text{n}.\text{k}/\text{o}.\text{ma}.\text{i}]$</td>
<td>$-1$</td>
<td>$-1_{\text{PWd}}$</td>
<td>$-7$</td>
</tr>
<tr>
<td>$\text{pw}_{\text{d}}[\text{i}/\text{n}.\text{k}/\text{o}.\text{ma}.\text{i}]$</td>
<td>$-1_{\sigma}, -1_{\text{PWd}}$</td>
<td>$-6$</td>
<td></td>
</tr>
</tbody>
</table>

Superset-at-edge patterns – weighting conditions:
- The basic weight of the Markedness constraint is greater than the basic weight of the conflicting Faithfulness constraint.
- The marked structure becomes allowed at whatever level of the hierarchy $w + s(d)$ for the Faithfulness constraint exceeds the weight of Markedness.

(17) a. Marked structure permitted everywhere  
Markedness $w = 1$  
Faithfulness $w = 2, s = 2$  

b. Marked structure permitted at PWd edge and up  
Markedness $w = 3$  
Faithfulness $w = 2, s = 2$
c. Marked structure permitted at PPh edge and up
Markedness \( w = 5 \)
Faithfulness \( w = 2, s = 2 \)

\[ \text{Marked structure permitted at Utterance edge only} \]
Markedness \( w = 9 \)
Faithfulness \( w = 2, s = 2 \)

Subset-at-edge patterns: fewer marked structures are permitted at more prominent boundaries.

(18) Guhang Ifugao (Newell 1956, Smith 2002) tolerates onsetless syllables word-medially, but requires onsets in word-initial syllables.

*Medial onsetless syllables* (Newell 1956:535, 538)
- bu.ūŋ 'an Ifugao necklace'
- ma.ŋá.an 'remove'
- ha.i.tan 'whetstone'

*Word-initial syllables must have onsets* (Newell 1956: 534-6)
- *uhup
- *iŋŋi
- *addaya

- Markedness, rather than faithfulness, is scaled.

(19) *Scaled \( D[V \)

Given a basic constraint weight \( w \),
a scale \( \{0, 1, \ldots, n\} \) corresponding to some dimension of prominence,
and a scaling factor \( s \),
For any vowel in initial position of domain \( d \in D \),
Assign a weighted violation score of \( w + s(d) \)

Example:
- Weight \( w = 2 \)
- Prominence scale = \{Syllable, PWd, PPh, Utterance\}
- Scaling factor \( s = 2 \)

\( \text{word-medial onsetless syllable: } *_d[V \text{ violation of } w + s(\text{Syllable}) = 2 + 2(0) = 2} \)
\( \text{word-initial onsetless syllable: } *_d[V \text{ violation of } w + s(\text{PWd}) = 2 + 2(1) = 4} \)

(20) *Word-initial syllables require onsets, not word-medial syllables*

<table>
<thead>
<tr>
<th></th>
<th>DEP ( w = 3 )</th>
<th>( *_d[V \text{ w = 2, s = 2} )</th>
<th>( H )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( pw_d[a.i.tan] )</td>
<td>-1.0, -1.0 ( pw_d )</td>
<td>-6</td>
<td></td>
</tr>
<tr>
<td>( pw_d[a.hi.tan] )</td>
<td>-1</td>
<td>-1.0 ( pw_d )</td>
<td>-7</td>
</tr>
<tr>
<td>( pw_d[ha.i.tan] )</td>
<td>-1.0, -1.0 ( pw_d )</td>
<td>-5</td>
<td></td>
</tr>
<tr>
<td>( pw_d[ha.hi.tan] )</td>
<td>-2</td>
<td>-2.0</td>
<td>-6</td>
</tr>
</tbody>
</table>

Subset-at-edge patterns – weighting conditions:
- The basic weight of the Faithfulness constraint is greater than the basic weight of the conflicting Markedness constraint.
- The marked structure becomes disallowed at whatever level of the hierarchy \( w + s(d) \) for the Markedness constraint exceeds the weight of Faithfulness.
(21) a. Marked structure permitted nowhere
   Markedness \( w = 2, s = 2 \)
   Faithfulness \( w = 1 \)

   ![Graph 1](image1.png)

b. Marked structure permitted at syllable edge only
   Markedness \( w = 2, s = 2 \)
   Faithfulness \( w = 3 \)

   ![Graph 2](image2.png)

c. Marked structure permitted at σ & PWd edge
   Markedness \( w = 2, s = 2 \)
   Faithfulness \( w = 5 \)

   ![Graph 3](image3.png)

d. Marked structure permitted at σ, PWd & Utt edges
   Markedness \( w = 2, s = 2 \)
   Faithfulness \( w = 9 \)

   ![Graph 4](image4.png)

If both Markedness and Faithfulness are scaled, the logic remains the same.

Superset-at-edge – weighting conditions with both constraints scaled:
- The basic weight of the Markedness constraint is greater than the basic weight of the conflicting Faithfulness constraint.
- The Faithfulness constraint has a greater scaling factor, allowing the Faithfulness penalty to exceed the Markedness penalty at some level.

(22) Word-initial syllables can be onsetless, not word-medial syllables

<table>
<thead>
<tr>
<th>/i-N-koma-i/</th>
<th>*d[V] ( w = 5, s = 1 )</th>
<th>d[DEP-INIT] ( w = 4, s = 3 )</th>
<th>( H )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p_{\text{wd}}[\text{in.ko.ma.i}] )</td>
<td>(-1_\sigma, -1_{\text{PWd}})</td>
<td>(-1_{\text{PWd}})</td>
<td>(-11)</td>
</tr>
<tr>
<td>( \text{\textit{a} [\text{in.ko.ma.ti}]} )</td>
<td>(-1_{\text{PWd}})</td>
<td>(-1_\sigma)</td>
<td>(-10)</td>
</tr>
<tr>
<td>( p_{\text{\textit{w}d}}[\text{in.ko.ma.i}] )</td>
<td>(-1_\sigma)</td>
<td>(-1_{\text{PWd}})</td>
<td>(-12)</td>
</tr>
<tr>
<td>( p_{\text{\textit{w}d}}[\text{in.ko.ma.ti}] )</td>
<td>(-1_\sigma, -1_{\text{PWd}})</td>
<td>(-11)</td>
<td></td>
</tr>
</tbody>
</table>

Subset-at-edge – weighting conditions with both constraints scaled:
- The basic weight of the Faithfulness constraint is greater than the basic weight of the conflicting Markedness constraint.
- The Markedness constraint has a greater scaling factor, allowing the Markedness penalty to exceed the Faithfulness penalty at some level.

(23) Word-initial syllables require onsets, not word-medial syllables

<table>
<thead>
<tr>
<th>/a.i.tan/</th>
<th>d[DEP-INIT] ( w = 5, s = 1 )</th>
<th>*d[V] ( w = 4, s = 3 )</th>
<th>( H )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p_{\text{\textit{w}d}}[\text{\textit{a}i.tan}] )</td>
<td>(-1_\sigma, -1_{\text{PWd}})</td>
<td>(-11)</td>
<td></td>
</tr>
<tr>
<td>( p_{\text{\textit{w}d}}[\text{\textit{a}hi.tan}] )</td>
<td>(-1_\sigma)</td>
<td>(-1_{\text{PWd}})</td>
<td>(-12)</td>
</tr>
<tr>
<td>( \text{\textit{a} [\text{\textit{w}d}h\text{a}.i.tan}] )</td>
<td>(-1_{\text{PWd}})</td>
<td>(-1_\sigma)</td>
<td>(-10)</td>
</tr>
<tr>
<td>( p_{\text{\textit{w}d}}[\text{\textit{ha}.hi.tan}] )</td>
<td>(-1_\sigma, -1_{\text{PWd}})</td>
<td>(-11)</td>
<td></td>
</tr>
</tbody>
</table>
Patterns with scaled markedness and faithfulness

a. Superset at edge (22)

5. Comparing OT and HG typologies

Summary: In Harmonic Grammar it is not necessary to include distinct indexed versions for positional markedness and faithfulness constraints. Instead, constraints can be scaled based on the relative prominence of the position in which their violations are incurred.

Scalar constraints cannot achieve the effect of driving repair vs. non-repair in Optimality Theory.

• Why not? OT constraints can only occupy one position in the hierarchy. If M >> F, the marked structure will be allowed in no context. If F >> M, the marked structure will be allowed in all contexts.

No superset-at-edge: If word-medial syllables can’t be onsetless, neither can word-initial syllables

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>p[V] s = 1</td>
<td>σ, PWd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d[DEP-INIT] s = 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No subset-at-edge: If word-initial syllables can be onsetless, so can word-medial syllables

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>p[V] s = 1</td>
<td>σ, PWd</td>
<td>σ</td>
<td>PWd</td>
<td>σ</td>
</tr>
<tr>
<td>d[DEP-INIT] s = 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Indexed positional markedness and faithfulness constraints predict unattested “level-skipping” patterns (see §3).

In HG with scalar constraints, “level-skipping” patterns cannot be generated.

• Why not? The relative importance of Markedness and Faithfulness can only be inverted once per prominence scale – i.e., the penalty lines only cross once.
• Level-skipping patterns rely on two (or more) inversions of relative M vs. F importance.
Typological comparison: OT vs. HG

<table>
<thead>
<tr>
<th>/NCV VV/</th>
<th>HG with scalar constraints</th>
<th>OT with scalar constraints</th>
<th>OT &amp; HG with indexed constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>pPh[pw[C.C] pWd[C.C]]</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>... onsetless never allowed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pPh[pw[V.C] pWd[V.V]]</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>... onsetless allowed everywhere</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pPh[pw[V.C] pWd[V.C]]</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>... onsetless allowed at PPh and PWD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pPh[pw[V.C] pWd[V.C]]</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>... onsetless allowed at PPh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pPh[pw[C.C] pWd[V.V]]</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>... onsetless allowed at medial PWD and σ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pPh[pw[C.C] pWd[C.C]]</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>... onsetless allowed at medial σ only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pPh[pw[V.C] pWd[V.C]]</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>... onsetless allowed at PPh and medial σ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pPh[pw[C.C] pWd[V.C]]</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>... onsetless allowed at medial PWD only</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Conclusion

Scalar constraints can be successfully applied to a variety of problems in HG – allowing for analytical solutions that are not possible in Optimality Theory.

- HG constraints scaled to levels of the prosodic hierarchy capture attested asymmetries while avoiding the “level-skipping” problems of indexed constraints.
- Weighted scalar constraints naturally account for implicational patterns of repair vs. non-repair along some dimension of prominence.

Scalar constraints in HG can be extended to account for implicational process application in other domains, such as lexical category effects or processes conditioned by morpho-syntactic derivations.

- Smith (2011): Given a hierarchy of phonological privilege by lexical category (i.e. N>A>V), avoidance of contrast neutralization within words of a given category implies preservation of the same contrast in all higher (or lower) categories of the hierarchy.
- Bermúdez-Otero (2011): If a process that applies in some inner morpho-syntactic domain fails to apply at a successive level of morphological derivation, it will also misapply in all higher domains. Such effects can be accounted for by scaling HG constraints to morphological boundaries, without having to posit a cyclic/stratal derivation (cf. Bermúdez-Otero 1999, Kiparsky 2000).

Remaining questions:

- Should general faithfulness and markedness constraints be incorporated into the scale, and if so, how?
- What is the best way of conceptualizing the interaction between constraints on prosodic organization and the scalar constraints discussed here? (see Appendix I)
- How is constraint scaling 'grounded' in processing or articulatory factors? Are scaling factors always linear?

Acknowledgements: Thanks to Rachel Walker, Louis Goldstein, Khalil Iskarous, Alan Yu, Paul de Lacy, Martin Krämer, and audiences at USC for helpful feedback on this project.
Appendix I. Strict Layering violations

The patterns discussed in the previous sections depend on strict hierarchical organization of prosodic constituents.

- We consider how the scalar HG model interacts with representations that deviate from two principles of Strict Layering (Selkirk 1984, Selkirk 1996): Exhaustivity and Nonrecursivity.

**Exhaustivity** requires prosodic constituents to exclusively dominate instances of the immediately lower category.

In representations that violate Exhaustivity, individual segments are not dominated by a constituent of each level of the prosodic hierarchy. Thus, they potentially escape markedness restrictions applied to the “skipped” levels.

(28) Tzutujil (Dayley 1985, Flack 2009): All roots surface with initial onsets; glottal stops are epenthized before underlyingly vowel-initial roots. Proclitics not contained within the root's PWd surface faithfully without onsets.

<table>
<thead>
<tr>
<th>Root</th>
<th>PWd</th>
<th>Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>/ak'/</td>
<td>→ <em>PPh PWd[ʔak']</em></td>
<td>'chicken'</td>
</tr>
<tr>
<td>/oxqat/</td>
<td>→ <em>PPh PWd[ʔoxqat]</em></td>
<td>'deer-hunter'</td>
</tr>
<tr>
<td>/in=winak/</td>
<td>→ <em>PPh PWd[ʔin=winak]</em></td>
<td>(*<em>PPh PWd[ʔin=winak]</em>)</td>
</tr>
<tr>
<td>/a:=tz'i:?/</td>
<td>→ <em>PPh PWd[a:=tz'i:?]</em></td>
<td>(*<em>PPh PWd[a:=tz'i:?]</em>)</td>
</tr>
</tbody>
</table>

Such patterns can be accounted for by scaled positional markedness in HG with the additional assumption that constraints are scaled according to the number of prosodic boundaries with which they are aligned.

- Assume that an onsetless syllable violates *D[V] at a base cost of \( w = 2 \), with a scaling factor of \( s = 2 \).
- Extraprosodic proclitics tolerate onsetlessness because they incur a lesser penalty for *D[V] by virtue of aligning with fewer prosodic boundaries.

(29) **Onsets are normally required, but extra-prosodic clitics escape**

<table>
<thead>
<tr>
<th>Root</th>
<th>DEP</th>
<th>*D[V]</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>PPh PWd[oxqat]</em></td>
<td>( w = 5, s = 0 )</td>
<td>( w = 2, s = 2 )</td>
<td>( -1 ) <em>PPh PWd</em></td>
</tr>
<tr>
<td><em>PPh PWd[ʔoxqat]</em></td>
<td>–1</td>
<td>*D[V]</td>
<td>( -5 )</td>
</tr>
<tr>
<td><em>PPh PWd[ʔin=winak]</em></td>
<td>DEP</td>
<td>–1 <em>PPh</em></td>
<td>( -4 )</td>
</tr>
<tr>
<td><em>PPh PWd[ʔin=winak]</em></td>
<td>–1</td>
<td>–1 <em>PPh</em></td>
<td>( -5 )</td>
</tr>
</tbody>
</table>

**Nonrecursivity** bans recursive representations where prosodic constituents dominate instances of an identical category (e.g., a PWd that dominates another PWd).

- If direct mappings from (recursive) syntactic to prosodic structure are favored (Wagner 2005, Selkirk 2011, Elfen 2012), the addition of syntactic structure increases the number of recursive PCats.
- Consider a language where every AdjP is mapped to a prosodic phrase (cf. Elfen 2012):

(30) a. [Adj [N]] → _PPh(Adj N)_
    b. [Adj [Adj [N]]] → _PPh(Adj PPh(Adj N))_
    c. [Adj [Adj [Adj [N]]]] → _PPh(Adj PPh(Adj PPh(Adj N)))_

If constraints are simply scaled based on the number of prosodic edges/domains that segments occur at, we might expect modified nouns to observe greater markedness or faithfulness restrictions than unmodified nouns.

- e.g., A word-final coda in a modified noun could incur more violations of *C[D] than the final coda of an unmodified noun, triggering repair only for modified nouns.

**One solution**: The number of violations that a candidate can receive is bounded at one per prosodic category type; recursive embedding of a given PCat has no effect on total markedness or faithfulness violations.
Appendix II. Domain-based restrictions

Markedness restrictions can hold within some prosodic constituent, but fail to apply across its boundaries.

- These patterns can be accounted for by domain span rules in rule-based phonology (Selkirk 1980), and in parallel OT by domain span constraints (Hsu 2014).

(31) French (Côté 2000: 279): tri-consonantal clusters (CCC) contained within PWds are obligatorily broken up by schwa-epenthesis (a). They are optionally repaired if broken up by a word boundary (b), and emerge faithfully across phrase boundaries (c).

- a. /ty=fe=k=t=muʃce/ → _PPh_{tyʃktmʃuc}_PWd[mʃc] (you only blow your nose)
- b. /ʃkt#muʃto/ → _PPh_{ʃkt}PWd[mʃto] (stinking coat)
- c. /l=ʃkt me=la=la/ → _PPh_{PPh}[ʃkt][PPh[mʃla]] (‘the insect, put it there’)

In HG, we can account for the pattern with a positional markedness constraint _D[*CCC]_, whose violations are scaled to the number of domains that a CCC cluster is fully contained within.

- The base violation is given for a CCC sequence with no reference to prosodic embedding, and scaled for each prosodic domain that fully contains the sequence.

(32) Scaled _D[*CCC]_

Given a basic constraint weight _w_,
a scale \{0, 1, … n\} corresponding to some set of domains,
and a scaling factor _s_,
For any triconsonantal sequence fully contained within a domain _d ∈ D_,
Assign a weighted violation score of _w + s(d)_.

Example:

Prominence scale = \{Utterance, PPh, PWd, Syllable\}
Scaling factor _s_ = 1

triconsonantal sequence within a PPh: _D[*CCC]_ violation of _w + s(PPh) = 2 + 1(1) = 3_
triconsonantal sequence within a PWd: _D[*CCC]_ violation of _w + s(PWd) = 2 + 1(2) = 4_

(33) A worse markedness penalty is incurred when the CCC sequence is embedded within more domains

<table>
<thead>
<tr>
<th>/l=ʃkt me=la=la /</th>
<th><em>D[*CCC]</em></th>
<th>DEP-V</th>
<th><em>H</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>_PPh[PWd[lʃkt]]_PWd[mʃla]]</td>
<td><em>D[*CCC]</em></td>
<td>DEP-V</td>
<td><em>H</em></td>
</tr>
</tbody>
</table>

Unlike with edge-based asymmetries, it is not clear if it is possible or necessary to define positional faithfulness constraints that are evaluated only within a prosodic span.

- We are unaware of minimal pairs of languages where a marked sequence emerges only within some prosodic domain in one language, but only across its boundaries in another.

References


