Computation, learning, and typology

Class 6: Meta-conditions

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Ranking meta-conditions

- Recall that with n constraints, there are $n!$ possible total rankings ($n \times n-1 \times n-2 \ldots n-(n-1)$)
- Recall also that the number of *distinct* patterns predicted by those $n!$ rankings is substantially $< n!$
- And yet: the resulting factorial typology for a given constraint set CON can result in
  (i) undesired patterns of particular types and/or
  (ii) undesired consequences for learning
  - **Option 1:** Revise CON: add, remove, substitute
  - **Option 2:** Suppose that not all rankings of the constraints in CON are created equal

Hard conditions

e.g. inviolable meta-rankings

How to capture absolute universals in OT

- **Jakobsonian observation:** There are languages that require syllables to *have* onsets, but no languages that require syllables to *not have* onsets
  - {ONSET, MAX, DEP} $\in$ CON; NOONSET $\notin$ CON
  - {ONSET, MAX} $\gg$ DEP = onsets required
    - enforced by C-epenthesis due to MAX $\gg$ DEP
  - {ONSET, DEP} $\gg$ MAX = onsets required
    - enforced by V-deletion due to DEP $\gg$ MAX
  - {DEP, MAX} $\gg$ ONSET = onsets not required, but emerge when faithfulness is not at stake: /...VCV.../ $\mapsto$ [...V.CV...], *[...VC.$\underline{\text{V}}$...]

How to capture absolute universals in OT

- **Jakobsonian observation:** There are languages that require syllables to *not have* codas, but no languages that require syllables to *have* codas
  - {NoCoda, Max, Dep} $\in$ CON; Coda $\notin$ CON
  - {NoCoda, Max} $\gg$ Dep = codas forbidden
    - enforced by V-epenthesis due to Max $\gg$ Dep
  - {NoCoda, Dep} $\gg$ Max = codas forbidden
    - enforced by C-deletion due to Dep $\gg$ Max
  - {Dep, Max} $\gg$ NoCoda = codas not forbidden, but do not emerge when faithfulness is not at stake: /...VCV.../ $\mapsto$ [...V.CV...], *[...$\underline{\text{VC}}$.V...]

How to accommodate different repair types in OT

- **Observation:** There are lgs that enforce both ONSET and NOCODA with epenthesis, lgs that enforce both with deletion, and lgs that enforce one with epenthesis and the other with deletion
  - No way to rank these constraints such that e.g. {NOCODA, MAX} $\gg$ DEP (epenthesis to avoid codas) and {ONSET, DEP} $\gg$ MAX (deletion to avoid onsetlessness)
  - (recall consistency of ranking discussion last Friday)

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  - (recall consistency of ranking discussion last Friday)
- **Solution:** split DEP into DEP-C, DEP-V (Prince & Smolensky, 2004[1993]) and/or MAX into MAX-C, MAX-V (most work since P&S assumes both)
  - {NOCODA, ONSET, DEP-V} $\gg$ MAX $\gg$ DEP-C

Two approaches to implicational universals

- **Given** this 4-level *sonority hierarchy*:

  4-vowels $\succ$ 3-liquids $\succ$ 2-nasals $\succ$ 1-obstruents

- **Observation 1: possible nuclei**

  If a lg admits n-level segments as nuclei, it also admits $n+1$-level segments as nuclei.

- **Observation 2: possible margins** (= onsets or codas)

  If a lg admits n-level segments as margins, it also admits $n-1$-level segments as margins

Two approaches to implicational universals

Assumptions about the system

- *Constraints:* $\{$*Nuc1O, *Nuc2N, *Nuc3L, *Nuc4V, *Mar4v, *Mar3l, *Mar2n, *Mar1o, Faith(xX)$\}$ $\in$ CON
- *GEN:* input margins (v, l, n, o) or nuclei (V, L, N, O) can be parsed as margins or as nuclei, violating Faith(xX) if parsed differently than in its input specification
- 9 constraints = 9! = 362,880 total rankings
- Predicted typology: 81 distinct patterns
    - every possible combination of nucleus and margin possibilities, in violation of Observations 1 & 2

Two approaches to implicational universals

Further assumption: universal meta-rankings (X $\ggg_{\text{UG}}$ Y)

- Nucleus sonority markedness subhierarchy
  *NUC1O $\ggg_{\text{UG}}$ *NUC2N $\ggg_{\text{UG}}$ *NUC3L $\ggg_{\text{UG}}$ *NUC4V
- Margin sonority markedness subhierarchy
  *MAR4v $\ggg_{\text{UG}}$ *MAR3l $\ggg_{\text{UG}}$ *MAR2n $\ggg_{\text{UG}}$ *MAR1o
- Predicted typology: 15 distinct patterns
  - Only those that obey Observations 1 & 2

Two approaches to implicational universals

Alternative: Revising CON with *stringency relations*

- Nucleus sonority stringency relations
  *Nuc1O $\prec$ *Nuc2NO $\prec$ *Nuc3LNO $\prec$ *Nuc4VLNO
- Margin sonority stringency relations
  *Mar4v $\prec$ *Mar3lv $\prec$ *Mar2nlv $\prec$ *Mar1onlv
- Predicted typology: 15 distinct patterns
  - Same ones: only those that obey Observations 1 & 2
- See de Lacy (2004) for discussion of some interesting differences between markedness subhierarchies *qua* universal meta-rankings v. stringency relations

Some other universal meta-ranking proposals

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  - *Alternative:* L/R is a parameter setting of a single ALIGN

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- Pater (2003) on possible disagreement repairs
  - 'SEGCOR' $\ggg_{\text{UG}}$ 'ASSIM'

    $= \{$MAX, DEP, LIN, UNIF, INTEG$\} \ggg_{\text{UG}} \{$AGREE, SPREAD, ALIGNF$\}$

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- Few if any convincing cases of R-to-L iambic lgs?
  - $\sigma\sigma\sigma\sigma\sigma \mapsto (\sigma\acute{\sigma})(\sigma\acute{\sigma})\sigma$: $\overset{2}{\text{AFL}}, \overset{4}{\text{AFR}}$; $*\sigma(\sigma\acute{\sigma})(\sigma\acute{\sigma})$: $\overset{^4\text{W}}{\text{AFL}}, \overset{^2\text{L}}{\text{AFR}}$
  - Universal conditional? *If* IA $\gg$ TR*, then* AFL $\gg$ AFR

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  - Universal conditional? *If* Ia $\gg$ Tr*, then* AFL $\gg$ AFR
  - But: degeneracy reverses direction (Crowhurst & Hewitt, 1994)
    - $\sigma\sigma\sigma\sigma\sigma \mapsto (\sigma\acute{\sigma})(\sigma\acute{\sigma})(\acute{\sigma})$: $\overset{6}{\text{AFL}}, \overset{4}{\text{AFR}}$; $*(\acute{\sigma})(\sigma\acute{\sigma})(\sigma\acute{\sigma})$: $\overset{4\text{L}}{\text{AFL}}, \overset{6\text{W}}{\text{AFR}}$
    - *If* Ia $\gg$ Tr, *then* AFL $\gg$ AFR, *unless P-σ* $\gg$ $\{$*AFL, AFR*$\}$, *in which case* AFR $\gg$ AFL

The P-Map (Steriade, 2009)

The *perceptibility map* (‘P-map’) imposes $\mathbb{F}$-rankings

- If $x \mapsto y$ is less perceptible than $x \mapsto z$, then $^*\mathbb{F}{:}x \mapsto z \ggg_{\mathrm{UG}} {}^*\mathbb{F}{:}x \mapsto y$

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Change to satisfy *[+voi]___ $]_\sigma$	Ranking	∃?
a. Devoicing: /tæb/ ↦ [.tæb.]	*[+voi]/___ $]_\sigma$ ≫ IDENT(voi)	✓
b. Nasalization: /tæb/ ↦ [.tæm.]	*[+voi]/___ $]_\sigma$ ≫ IDENT(nas)	X
c. Lenition to glide: /tæb/ ↦ [.tæw.]	*[+voi]/___ $]_\sigma$ ≫ IDENT(cons)	X
d. Consonant deletion: /tæb/ ↦ [.tæ.]	*[+voi]/___ $]_\sigma$ ≫ MAX-C	X
e. Vowel epenthesis: /tæb/ ↦ [.tæ.bə.]	*[+voi]/___ $]_\sigma$ ≫ MAX-C	X
f. Segment reversal: /tæb/ ↦ [.bæt.]	*[+voi]/___ $]_\sigma$ ≫ LINEARITY(seg)	X
g. Feature reversal: /tæb/ ↦ [.dæp.]	*[+voi]/___ $]_\sigma$ ≫ LINEARITY(feat)	X

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b. Nasalization: /tæb/ $\mapsto$ [.tæm.]	$^*[+\text{voi}]/\_\_\,]_\sigma \gg$ IDENT(nas)	X
c. Lenition to glide: /tæb/ $\mapsto$ [.tæw.]	$^*[+\text{voi}]/\_\_\,]_\sigma \gg$ IDENT(cons)	X
d. Consonant deletion: /tæb/ $\mapsto$ [.tæ.]	$^*[+\text{voi}]/\_\_\,]_\sigma \gg$ MAX-C	X
e. Vowel epenthesis: /tæb/ $\mapsto$ [.tæ.bə.]	$^*[+\text{voi}]/\_\_\,]_\sigma \gg$ MAX-C	X
f. Segment reversal: /tæb/ $\mapsto$ [.bæt.]	$^*[+\text{voi}]/\_\_\,]_\sigma \gg$ LINEARITY(seg)	X
g. Feature reversal: /tæb/ $\mapsto$ [.dæp.]	$^*[+\text{voi}]/\_\_\,]_\sigma \gg$ LINEARITY(feat)	X

- Compare Lombardi (1999, 2001): deletion incurs a strict superset of the $\mathbb{F}$-violations incurred by devoicing

Meta-ranking as a defeasible learning bias

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  - If no contrary evidence, assume paradigm uniformity
- Smith (2000); Hayes (2004): $\{\mathbb{M}, \mathbb{F}^s\} \ggg_{\text{LB}} \mathbb{F}^g$
  - But see Prince & Tesar (2004) on establishing *s* vs. *g*

Meta-ranking as a defeasible learning bias

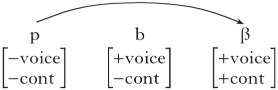
- Hayes & White (2015) on *saltation maps*
  - A saltation map in Campidanian Sardinian

    [piʃːi] ‘fish’ [belːu βiʃːi] ‘nice fish’ p $\sim$ VβV

    [bĩu] ‘wine’ [sːu bĩu] ‘the wine’ b $\sim$ VbV

- $\{(x \mapsto z, y \mapsto y)\}$; y is ‘intermediate’ between x and z

(3) *The saltation path in Campidanian*



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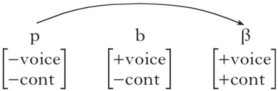

- Saltations are possible, but they’re typologically rare and more challenging to learn (White, 2013, 2014)
  - $\mathbb{F}$:*Map$(x, z) \ggg_{\text{LB}} \{\mathbb{F}$:*Map$(x, y)$, $\mathbb{F}$:*Map$(y, z)\}$

*Map(x, y) (Zuraw, 2013): x, y = natural classes a.o.t. single feature values; cf. McCarthy & Prince (1995)

Broad sketch of the learning of a saltation grammar

$\mathbb{M}$-constraints: $\left\{\mathbb{M}\text{:*apa}, \mathbb{M}\text{:*a}\begin{Bmatrix}\text{p}\\ \text{b}\end{Bmatrix}\text{a}, \mathbb{M}\text{*}\beta, \mathbb{M}\text{:*b}\right\}$

$\mathbb{F}$-constraints: $\left\{\mathbb{F}\text{:*}\textsc{Map}(\text{p},\beta) \ggg_{\textsc{lb}} \left\{\mathbb{F}\text{:*}\textsc{Map}(\text{p},\text{b}), \mathbb{F}\text{:*}\textsc{Map}(\text{b},\beta)\right\}\right\}$

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Observation	*Ranking learned*
a. /pa/ $\mapsto$ [pa]	*n/a*

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$\mathbb{F}$-constraints: $\left\{\mathbb{F}\text{:*M}\textsc{ap}\text{(p,β)} \ggg_{\textsc{lb}} \left\{\mathbb{F}\text{:*M}\textsc{ap}\text{(p,b)},\ \mathbb{F}\text{:*M}\textsc{ap}\text{(b,β)}\right\}\right\}$

Observation	*Ranking learned*
a. /pa/ $\mapsto$ [pa]	*n/a*
b. /ba/ $\mapsto$ [ba]	$[\![\mathbb{F}\text{:*M}\textsc{ap}\text{(p,b)} \gg \mathbb{M}\text{:*b}]\!] \wedge [\![\{\mathbb{F}\text{:*M}\textsc{ap}\text{(b,β)} \vee \mathbb{M}\text{:*β}\} \gg \mathbb{M}\text{:*b}]\!]$

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$\mathbb{F}$-constraints: $\{\mathbb{F}$:*Map(p,β) $\ggg_{\text{LB}}$ $\{\mathbb{F}$:*Map(p,b), $\mathbb{F}$:*Map(b,β)$\}\}$

Observation	*Ranking learned*
a. /pa/ $\mapsto$ [pa]	*n/a*
b. /ba/ $\mapsto$ [ba]	$[\![\mathbb{F}$:*Map(p,b) $\gg$ $\mathbb{M}$:*b$]\!]$ $\wedge$ $[\![\{\mathbb{F}$:*Map(b,β) $\vee$ $\mathbb{M}$:*β$\}$ $\gg$ $\mathbb{M}$:*b$]\!]$
c. /aba/ $\mapsto$ [aba]	$[\![\{\mathbb{F}$:*Map(b,β) $\vee$ $\mathbb{M}$:*β$\}$ $\gg$ $\mathbb{M}$:*a$\left\{\begin{smallmatrix}\text{p}\\\text{b}\end{smallmatrix}\right\}a]\!]$

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c. /aba/ $\mapsto$ [aba]	$[\![\{\mathbb{F}$:*Map(b,β) $\vee$ $\mathbb{M}$:*β$\}$ $\gg$ $\mathbb{M}$:*a$\begin{Bmatrix}\text{p}\\\text{b}\end{Bmatrix}a]\!]$
d. /apa/ $\mapsto$ [aβa]	$[\![\{\mathbb{M}$:*apa, $\mathbb{M}$:*a$\begin{Bmatrix}\text{p}\\\text{b}\end{Bmatrix}a\}$ $\gg$ $\{\mathbb{F}$:*Map(p,β), $\mathbb{M}$:*β$\}]\!]$

Broad sketch of the learning of a saltation grammar

$\mathbb{M}$-constraints: $\{\mathbb{M}\text{:*apa}, \mathbb{M}\text{:*a}\left\{\begin{smallmatrix}\text{p}\\\text{b}\end{smallmatrix}\right\}\text{a}, \mathbb{M}\text{*β}, \mathbb{M}\text{:*b}\}$

$\mathbb{F}$-constraints: $\{\mathbb{F}\text{:*}\textsc{Map}\text{(p,β)} \ggg_{\text{LB}} \{\mathbb{F}\text{:*}\textsc{Map}\text{(p,b)}, \mathbb{F}\text{:*}\textsc{Map}\text{(b,β)}\}\}$

Observation	*Ranking learned*
a. /pa/ ↦ [pa]	*n/a*
b. /ba/ ↦ [ba]	$[\![\mathbb{F}\text{:*}\textsc{Map}\text{(p,b)} \gg \mathbb{M}\text{:*b}]\!] \wedge [\![\{\mathbb{F}\text{:*}\textsc{Map}\text{(b,β)} \vee \mathbb{M}\text{:*β}\} \gg \mathbb{M}\text{:*b}]\!]$
c. /aba/ ↦ [aba]	$[\![\{\mathbb{F}\text{:*}\textsc{Map}\text{(b,β)} \vee \mathbb{M}\text{:*β}\} \gg \mathbb{M}\text{:*a}\left\{\begin{smallmatrix}\text{p}\\\text{b}\end{smallmatrix}\right\}\text{a}]\!]$
d. /apa/ ↦ [aβa]	$[\![\{\mathbb{M}\text{:*apa}, \mathbb{M}\text{:*a}\left\{\begin{smallmatrix}\text{p}\\\text{b}\end{smallmatrix}\right\}\text{a}\} \gg \{\mathbb{F}\text{:*}\textsc{Map}\text{(p,β)}, \mathbb{M}\text{:*β}\}]\!]$

Given $[\![\mathbb{M}\text{:*a}\left\{\begin{smallmatrix}\text{p}\\\text{b}\end{smallmatrix}\right\}\text{a} \gg \mathbb{M}\text{:*β}]\!]$ (d), it must be that $[\![\mathbb{F}\text{:*}\textsc{Map}\text{(b,β)} \gg \mathbb{M}\text{:*a}\left\{\begin{smallmatrix}\text{p}\\\text{b}\end{smallmatrix}\right\}\text{a}]\!]$ (c);
given $[\![\mathbb{M}\text{:*a}\left\{\begin{smallmatrix}\text{p}\\\text{b}\end{smallmatrix}\right\}\text{a} \gg \mathbb{F}\text{:*}\textsc{Map}\text{(p,β)}]\!]$ (d), $[\![\mathbb{F}\text{:*}\textsc{Map}\text{(b,β)} \gg \mathbb{F}\text{:*}\textsc{Map}\text{(p,β)}]\!]$ (transitivity)

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