Complexity as a solution to GLA-style learning challenges

In the context of Balto-Finnic vowel typology

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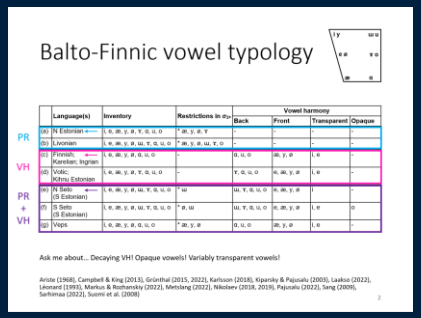
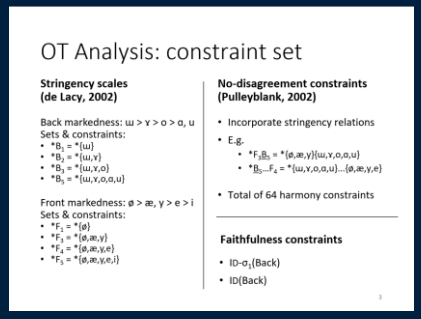
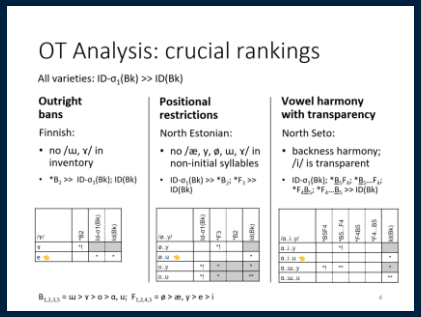
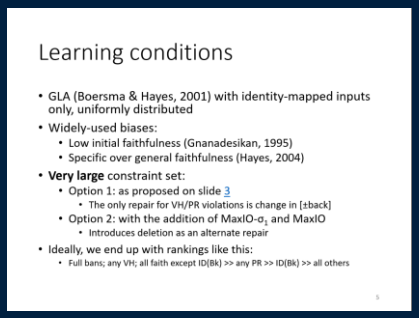
Part I: Typology and analysis

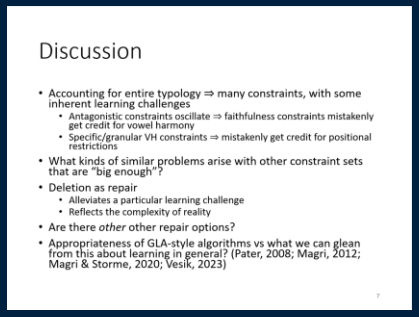




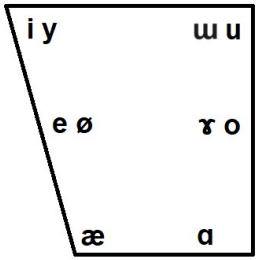


Part II: Learning challenges





Balto-Finnic vowel typology



		Language(s)	Inventory	Restrictions in σ_{2+}	Vowel harmony			
					Back	Front	Transparent	Opaque
PR	(a)	N Estonian ←	i, e, æ, y, ø, ɤ, ɑ, u, o	* æ, y, ø, ɤ	-	-	-	-
PR	(b)	Livonian	i, e, æ, y, ø, ɯ, ɤ, ɑ, u, o	* æ, y, ø, ɯ, ɤ, o	-	-	-	-
VH	(c)	Finnish; Karelian; Ingrian ←	i, e, æ, y, ø, ɑ, u, o	-	ɑ, u, o	æ, y, ø	i, e	-
VH	(d)	Votic; Kihnu Estonian	i, e, æ, y, ø, ɤ, ɑ, u, o	-	ɤ, ɑ, u, o	e, æ, y, ø	i, e	-
PR + VH	(e)	N Seto (S Estonian) ←	i, e, æ, y, ø, ɯ, ɤ, ɑ, u, o	* ɯ	ɯ, ɤ, ɑ, u, o	e, æ, y, ø	i	-
PR + VH	(f)	S Seto (S Estonian)	i, e, æ, y, ø, ɯ, ɤ, ɑ, u, o	* ø, ɯ	ɯ, ɤ, ɑ, u, o	e, æ, y, ø	i, e	o
PR + VH	(g)	Veps	i, e, æ, y, ø, ɑ, u, o	* æ, y, ø	ɑ, u, o	æ, y, ø	i, e	-

Ask me about… Decaying VH! Opaque vowels! Variably transparent vowels!

Ariste (1968), Campbell & King (2013), Grünthal (2015, 2022), Karlsson (2018), Kiparsky & Pajusalu (2003), Laakso (2022), Léonard (1993), Markus & Rozhanskiy (2022), Metslang (2022), Nikolaev (2018, 2019), Pajusalu (2022), Sang (2009), Sarhimaa (2022), Suomi et al. (2008)

OT Analysis: constraint set

Stringency scales (de Lacy, 2002)

Back markedness: ɯ > ɤ > o > ɑ, u
Sets & constraints:

- *B_1 = *{ɯ}
- *B_2 = *{ɯ,ɤ}
- *B_3 = *{ɯ,ɤ,o}
- *B_5 = *{ɯ,ɤ,o,ɑ,u}

Front markedness: ø > æ, y > e > i
Sets & constraints:

- *F_1 = *{ø}
- *F_3 = *{ø,æ,y}
- *F_4 = *{ø,æ,y,e}
- *F_5 = *{ø,æ,y,e,i}

No-disagreement constraints (Pulleyblank, 2002)

- Incorporate stringency relations
- E.g.
  - *$F_3\underline{B}_5$ = *{ø,æ,y}{ɯ,ɤ,o,ɑ,u}
  - *$\underline{B}_5$…F_4 = *{ɯ,ɤ,o,ɑ,u}...{ø,æ,y,e}
- Total of 64 harmony constraints

Faithfulness constraints

- ID-σ_1(Back)
- ID(Back)

OT Analysis: crucial rankings

All varieties: ID-σ_1(Bk) >> ID(Bk)

Outright bans

Finnish:

- no /ɯ, ɤ/ in inventory
- *B_2 >> ID-σ_1(Bk); ID(Bk)

/ɤ/	*B2	Id-σ1(Bk)	Id(Bk)
ɤ	*!		
e 👈		*	*

Positional restrictions

North Estonian:

- no /æ, y, ø, ɯ, ɤ/ in non-initial syllables
- ID-σ_1(Bk) >> *B_2; *F_3 >> ID(Bk)

/ø..y/	Id-σ1(Bk)	*F3	*B2	Id(Bk)
ø..y		*!		
ø..u 👈				*
o..y	*!	*		*
o..u	*!	*		**

Vowel harmony with transparency

North Seto:

- backness harmony; /i/ is transparent
- ID-σ_1(Bk); *$\underline{B_5}F_4$; *$\underline{B_5}$…F_4; *$F_4\underline{B_5}$; *F_4…$\underline{B_5}$ >> ID(Bk)

/ɑ..i..y/	*B5F4	*B5...F4	*F4B5	*F4...B5	Id(Bk)
ɑ..i..y		*!			
ɑ..i..u 👈					*
ɑ..ɯ..y	*!	**			*
ɑ..ɯ..u					**

$B_{1,2,3,5}$ = ɯ > ɤ > o > ɑ, u; $F_{1,2,4,5}$ = ø > æ, y > e > i

Learning conditions

- GLA (Boersma & Hayes, 2001) with identity-mapped inputs only, uniformly distributed
- Widely-used biases:
  - Low initial faithfulness (Gnanadesikan, 1995)
  - Specific over general faithfulness (Hayes, 2004)
- **Very large** constraint set:
  - Option 1: as proposed on slide 3
    - The only repair for VH/PR violations is change in [±back]
  - Option 2: with the addition of MaxIO-σ_1 and MaxIO
    - Introduces deletion as an alternate repair
- Ideally, we end up with rankings like this:
  - Full bans; any VH; all faith except ID(Bk) >> any PR >> ID(Bk) >> all others

Full bans; any VH; all faith except ID(Bk) >> any PR >> ID(Bk) >> all others

Results excerpts

North Estonian (PR)

☹ Option 1

Id-Syl1(Bk)	124.000
*F3	110.000
*B2	110.000
*F1	108.000
*B1	106.000
*F5..._B2	106.000
*_B5...F3	106.000
*_B5F3	104.000
Id(Bk)	104.000
*F5_B2	102.000
*B5	100.000
*F5	100.000

PRs too high

☹ Option 2

MaxIO-Syl1	112.000
Id-Syl1(Bk)	110.200
*B1	100.000
*F5_B2	100.000
*F5..._B2	100.000
*_B5F3	100.000
*_B5...F3	100.000
MaxIO	92.000
Id(Bk)	90.200
*F1	90.000
*B2	88.200
*F3	80.000
*B5	46.200
*F5	37.800

PRs too low

Finnish (VH)

☹ Option 1

Id-Syl1(Bk)	136.220
Id(Bk)	116.220
*_B5...F3	112.000
*_B5F3	110.000
*B2	110.000
*F3..._B5	108.020
*F1	105.800
*B3	104.200
*F3_B5	102.000
*B1	102.000
*B5	100.220
*F5	99.780

Id(Bk) too high

🙂 Option 2

MaxIO-Syl1	118.000
Id-Syl1(Bk)	114.002
*B1	100.000
*B2	100.000
*F3_B5	100.000
*F3..._B5	100.000
*_B5F3	100.000
*_B5...F3	100.000
MaxIO	98.000
Id(Bk)	94.002
*F1	85.998
*B3	70.002
*B5	50.002
*F5	45.998

OK – too close?

North Seto (PR+VH)

☹ Option 1

Id-Syl1(Bk)	132.000
Id(Bk)	112.000
*_B5...F4	108.000
*F4_B5	106.000
*F4..._B5	106.000
*_B5F4	106.000
*B1	104.000
*F4	102.000
*B3	102.000
*F5	100.000
*B5	100.000

Id(Bk) too high

😐 Option 2

MaxIO-Syl1	118.000
Id-Syl1(Bk)	114.000
*F4_B5	100.000
*F4..._B5	100.000
*_B5F4	100.000
*_B5...F4	100.000
MaxIO	98.000
*B1	94.000
Id(Bk)	94.000
*F4	86.000
*F5	56.000
*B3	48.000
*B5	42.000

Too close!

$B_{1,2,3,5}$ = ɯ > ɤ > o > ɑ, u; $F_{1,2,4,5}$ = ø > æ, y > e > i

Discussion

- Accounting for entire typology ⇒ many constraints, with some inherent learning challenges
  - Antagonistic constraints oscillate ⇒ faithfulness constraints mistakenly get credit for vowel harmony
  - Specific/granular VH constraints ⇒ mistakenly get credit for positional restrictions
- What kinds of similar problems arise with other constraint sets that are “big enough”?
- Deletion as repair
  - Alleviates a particular learning challenge
  - Reflects the complexity of reality
- Are there *other* other repair options?
- Appropriateness of GLA-style algorithms vs what we can glean from this about learning in general? (Pater, 2008; Magri, 2012; Magri & Storme, 2020; Vesik, 2023)

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