Necessary biases for algorithmic learning of Kihnu Estonian vowel harmony

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KIHNU ESTONIAN VOWEL HARMONY

Kihnu Estonian (KE) is one of just a few Estonian varieties with VH (front-back, progressive).

- Inventory: /i, e, æ, y, ø, ɤ, ɑ, u, o/
- Alternating: /y/-/u/, /æ/-/ɑ/, /e/-/ɤ/
- Transparent: /i/

Front harmonic	Back harmonic	Disharmonic
yhes (one.SG.INE)	puhɑst (clean.SG.PART)	*yhɤs, *puhæst
tekijæ (doer.SG.NOM)	tulinɤ (hot.SG.NOM)	* tekijɑ, *tuline
elæsime (live.1PL.PST)	olimɤ (be.1PL.PST)	*elæsimɤ, *olime

CONSTRAINT SETS

Kiparsky & Pajusalu[6] (K&P) propose constraints to account for Balto-Finnic harmony typology:

- IDσ$_1$(Bk)
- ID(Bk)
- Agree(Bk)
- *ɤ
- *æ, * ø, *y
- VH(æ, ø, y) = Agr(Bk) & *æ, * ø, *y

Conjoined "VH(x)" constraints ban disharmony involving vowel(s) *x*.

/æ..o/	VH(æ,ø,y)	IDσ$_1$(Bk)	ID(Bk)	*æ,*ø,*y
a. æ..o	*!			*
b. ☞ æ..ø			*	**
c. ɑ..o		*!	*	

K&P's constraints cannot account for KE's alternating /e/ but transparent /i/:

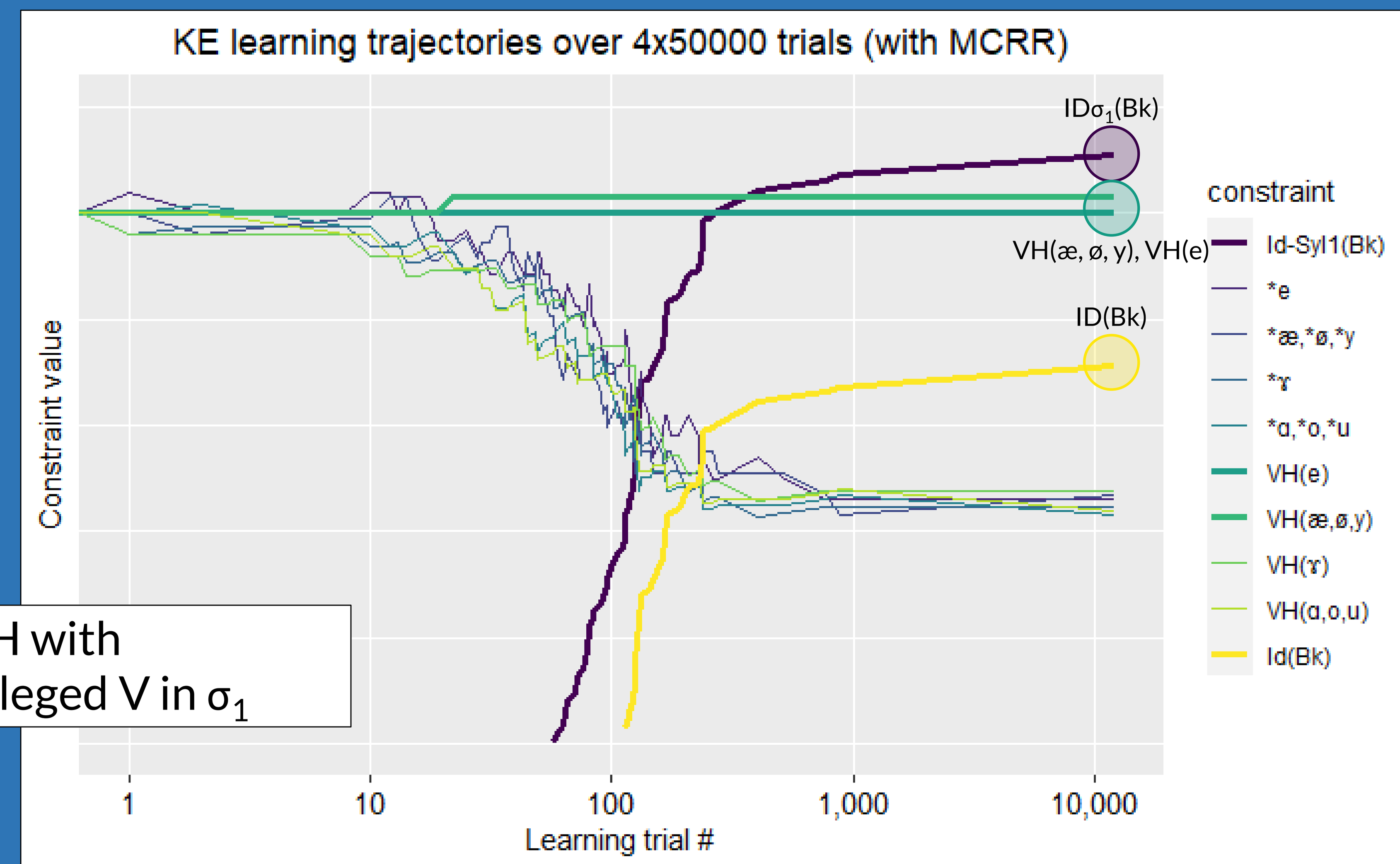
/u..i..e/	VH(æ,ø,y)	IDσ$_1$(Bk)	ID(Bk)	*e
a. ☞ u..i..e				*
b. ☹ u..i..ɤ			*	
c. y..i..e		*!	*	*

I propose[9] these additions to K&P's:

- VH(ɤ)
- *e
- VH(e)
- *ɑ, *u, *o
- VH(ɑ, u, o)

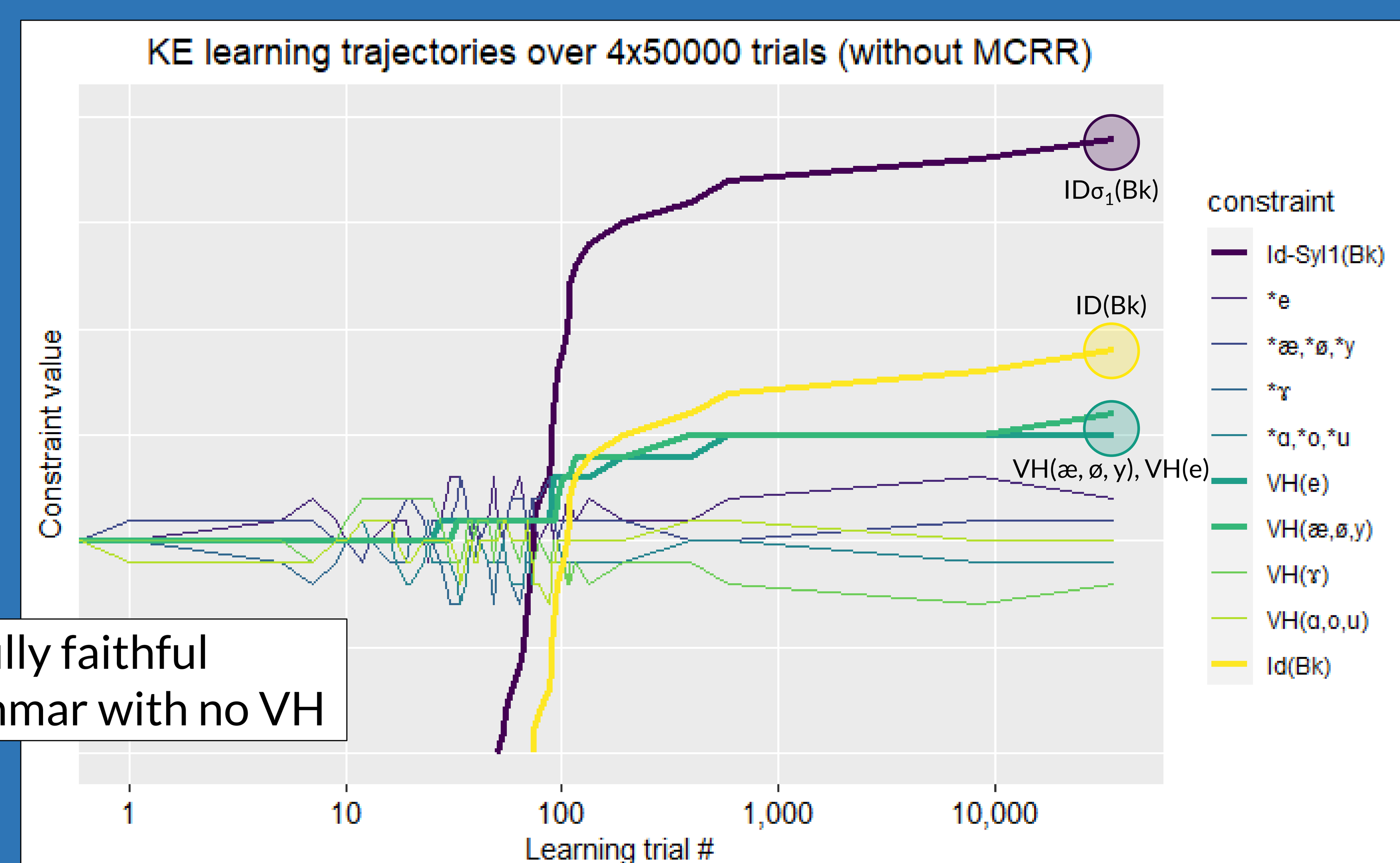
/u..i..e/	VH(e)	IDσ$_1$(Bk)	ID(Bk)	*e
a. u..i..e	*!			*
b. ☞ u..i..ɤ			*	
c. y..i..e		*!	*	*

Magri's *calibrated* re-ranking rule[8] addresses antagonistic markedness constraint behaviour in addition to the *credit problem*[2]



/æ..o/	IDσ$_1$(Bk)	VH(æ,ø,y)	VH(e)	ID(Bk)
a. æ..o		*!		
b. ☞ æ..ø				*
c. ɑ..o	*!			*

/u..i..e/	IDσ$_1$(Bk)	VH(æ,ø,y)	VH(e)	ID(Bk)
a. u..i..e			*!	
b. ☞ u..i..ɤ				*
c. y..i..e	*!			*



/æ..o/	IDσ$_1$(Bk)	ID(Bk)	VH(æ,ø,y)	VH(e)
a. ☞ æ..o			*	
b. ☹ æ..ø		*!		
c. ɑ..o	*!	*		

/u..i..e/	IDσ$_1$(Bk)	ID(Bk)	VH(æ,ø,y)	VH(e)
a. ☞ u..i..e				*
b. ☹ u..i..ɤ		*!		
c. y..i..e	*!	*		

GRADUAL LEARNING

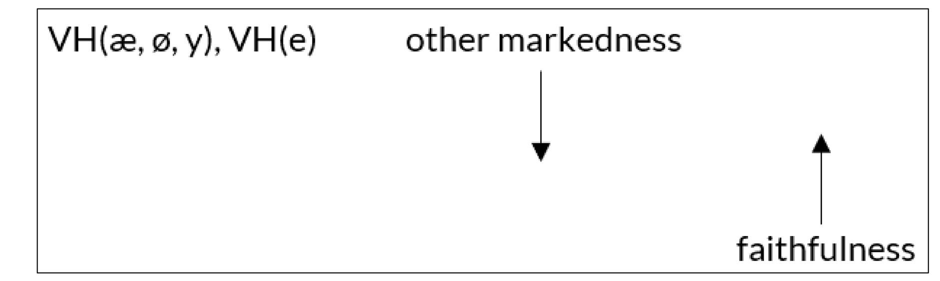
Gradual Learning Algorithm:[1]

- Error-driven, gradual
- Implemented by OTSoft[5] and Vesik[9]
- Relative frequencies of input forms from Estonian Dialect Corpus[7] (EDC)
- Including two widely-used biases:

Bias	Result if omitted
Low initial faithfulness[3]	IDσ$_1$(Bk) >> ID(Bk) >> VH(æ, ø, y), VH(e) Fully faithful grammar with no VH
Specific over gen. faith[4]	VH(æ, ø, y), VH(e) >> ID(Bk) >> IDσ$_1$(Bk) VH present but σ$_1$'s V not preserved

MAGRI'S CALIBRATED RE-RANKING RULE

- Need markedness constraints to fall while VH constraints remain high.



But:

- *ɤ and *e are antagonistic; oscillate instead of falling.
- Violation profile for a sample GLA learning error:

/ɤ..u/	VH(æ,ø,y)	VH(e)	*æ,*ø,*y	*e	*ɤ	IDσ$_1$(Bk)	ID(Bk)
a. ✓ ɤ..u					L** →		
b. ☞ e..y			← W*	← W*		← W*	← W**

Magri's[8] calibrated re-ranking rule (MCRR):

- Proposed to mitigate concerns associated with the Credit Problem.[2]
- Here, ensures that certain markedness constraints fall which otherwise wouldn't.

$$\textit{promotion amount} = \frac{\textit{number of constraints demoted}}{1 + \textit{number of constraints promoted}} \times \textit{plasticity}$$

SO WHAT?

This highlights the idea that problems associated with the behaviour of antagonistic constraints can be mitigated by the application of a solution (Magri's calibrated re-ranking rule) that was originally proposed to solve a different problem. Which other kinds of scenarios might benefit from the same?

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