When is derived [i] transparent?

A subtractive approach to Uyghur vowel harmony

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1 Introduction

- Phonological patterns often seem to ignore redundant features and apply only to contrastive ones.
- Two kinds of theoretical approaches:

  Subtractive – Make representations **sparser**: Only contrastive features are specified (e.g., Archangeli 1988; Dresher 2009, 2013, 2015; Hall 2007, 2017; Mackenzie 2009, 2011, 2013).

  Additive – Make representations **richer**: Both contrastive and redundant features are specified, *and* the phonological computation can distinguish between them (e.g., Calabrese 1995; Halle, Vaux & Wolfe 2000; Vaux 2000; Nevins 2010, 2015).

- Uyghur vowel harmony:
  - Underlying /i/, which has no back counterpart, is transparent.
  - In suffixes, [i] derived from underlying harmonic vowels is transparent.
  - In roots, [i] derived from back vowels is transparent, but [i] derived from front vowels is not.
- Halle, Vaux & Wolfe (2000) and Vaux (2000) propose an additive account.
- Our goal: Show that the subtractive approach can account for the Uyghur patterns.

2 The basic pattern of harmony and transparency

	FRONT		BACK	
	UNRND	ROUND	UNRND	ROUND
HIGH	i	y		u
MID	e	ø		o
LOW	æ		ɑ	

Table 1: Uyghur vowel inventory

- Front–back pairs participate in harmony: y–u, ø–o, æ–ɑ
- Harmony propagates rightward from roots to suffixes, as shown in (1)–(4) with data from Hahn (1991a); Schwarz (1992); Vaux (2000); D'Arcy (2004); Csató & Uchturpani (2010).

(1) Front stems plus causative -dUr

a.	yn-dyr	'sprout, appear'+CAUS.
b.	søk-tyr	'take apart'+CAUS.
c.	ʧæk-tyr	'smoke'+CAUS.

(2) Back stems plus causative -dUr

a.	sun-dur	'break'+CAUS.
b.	qop-tur	'get up'+CAUS.
c.	bɑq-tur	'raise'+CAUS.

(3) Front stems plus plural -lAr

a.	jyz-lær	'face'+PL.
b.	køl-lær	'lake'+PL.
c.	xæt-lær	'letter'+PL.

(4) Back stems plus plural -lAr

a.	pul-lɑr	'money'+PL.
b.	jol-lɑr	'road'+PL.
c.	ɑt-lɑr	'horse'+PL.

- Unpaired /i/ can occur in both front and back stems, as in (5) and (6), and is transparent to harmony; data from Schwarz (1992). (The other unpaired vowel, /e/, occurs mostly in loanwords and as a result of umlaut.)

(5) /i/ in front stems plus causative -dUr

a.	iʃæn-dyr	'believe'+CAUS.
b.	ʧiʃlæʃ-tyr	'mesh, bite.RECIP'+CAUS.
c.	zæʔiplæʃ-tyr	'weaken'+CAUS.

(6) /i/ in back stems plus causative -dUr

a.	ɑrtil-dur	'have loaded on'+CAUS.
b.	ziʧlɑʃ-tur	'become close'+CAUS.
c.	huʃsizlɑn-dur	'lose consciousness'+CAUS.

- /i/ in suffixes is also transparent, as in (7) and (8); data from Vaux (2000).

(7) Front stems + /-imiz/ + dative /-GA/

a.	jyz-imiz-gæ	'face'+'our'+DAT.
b.	køl-imiz-gæ	'lake'+'our'+DAT.

(8) Back stems + /-imiz/ + dative /-GA/

a.	pul-imiz-ʁɑ	'money'+'our'+DAT.
b.	jol-imiz-ʁɑ	'road'+'our'+DAT.

- Phonetically, the vowel labelled /i/ can be pretty much any unrounded vowel at least as high as /e/ or /ɤ/, depending on the surrounding consonants; the default realization is [ɪ] (Hahn 1991a: §4.1.1).
- Some stems with only neutral vowels take front suffixes, as in (9), but they more usually take back suffixes, as in (10); data from Pattillo (2013); Schwarz (1992); Lindblad (1990).

(9) Front 'neutral' stems

a.	bilim-gæ	'knowledge'+DAT.
b.	kir-gæ	'dirt'+DAT.
c.	birik-tyr	'join, tie'+CAUS.
d.	ʧekin-dyr	'retreat'+CAUS.

(10) Back 'neutral' stems

a.	sinip-qɑ	'classroom'+DAT.
b.	til-ʁɑ	'tongue, language'+DAT.
c.	tin-dur	'feel peaceful'+CAUS.
d.	siʁiʃ-dur	'hold, contain'+CAUS.

- This leads Hahn (1991a) to say that there is an underlying contrast between /i/ and /ɨ/, neutralized at the surface.
- Lindblad (1990) and Hahn (1991b) also posit an underlying back counterpart to /e/.
- The alternative to adding phonemes is to posit morpheme-level specifications—either diacritics or floating features (Vaux 2000).
- As Lindblad (1990) and Pattillo (2013) point out, vowel–consonant interactions make it possible in many (but not all) cases to predict which suffixes a neutral-vowel root will take.
  - Velar consonants generally go with front vowels, and uvular consonants with back vowels, as in the forms of the dative suffix in (7)–(10).
  - So we find pairs like the neutral-vowel roots in (11) and (12); data from Hahn (1991a: 48).

(11)

a.	kij-mæ	'wear'+NEG.
b.	kij-gy	'wear'+DESIDERATIVE

(12)

a.	qij-mɑ	'cut'+NEG.
b.	qij-ʁu	'cut'+DESIDERATIVE

3 Derived transparency in suffixes

- There are also some non-harmonizing suffixes. E.g., diminutive/approximative/similative *-ʧæ* remains front even after back stems (examples from Schwarz 1992: 1063, who treats this as three suffixes):

(13) a. kitɑp-ʧæ 'booklet' ('book'+*ʧæ*)
b. uzun-ʧæ 'longish' ('long'+*ʧæ*)
c. ujʁur-ʧæ 'Uyghur-like' ('Uyghur'+*ʧæ*)
d. loji-lɑr-ʧæ 'bureaucratic' ('bureaucrat'+PL.+*ʧæ*)

- Suffixes following *-ʧæ* show front harmony, as in (14); data from Hahn (1991b: 94).

(14) a. næj-ʧæ-m-dæ 'in my little flute' ('flute'+*ʧæ*+1SG.POSS.+LOCATIVE)
b. kitɑp-ʧæ-m-dæ 'in my booklet' ('book'+*ʧæ*+1SG.POSS.+LOCATIVE)

- In medial open syllables, the low vowels /æ/ and /ɑ/ raise to [i], as shown in (15) with examples from Hahn (1991a: 52–53).

(15) a. tø.pæ 'peak' tø.pi:lær 'peak'+PL. tø.pi:li.r-i 'peak'+PL.+3PL.POSS
b. sæ.pær 'journey' sæ.pi.r-im 'journey'+1SG.POSS.
c. bɑ.lɑ 'child' bɑ.li:lɑr 'child'+PL.
d. je.zɑ 'village' je.zi:dɑ 'village'+LOCATIVE

- When raising applies to the suffix *-ʧæ*, it becomes transparent; contrast (14b) with (16b), also from Hahn (1991b: 94).

(16) a. næj-ʧi-dæ 'in the little flute' ('flute'+*ʧæ*+LOCATIVE)
b. kitɑp-ʧi-dɑ 'in the booklet' ('book'+*ʧæ*+LOCATIVE)

4 Transparency and contrast: The two approaches

- Representations can make a connection between the transparency of /i/ and the fact that it does not contrast with a back counterpart.
- Two representational approaches:
  - Subtractive: /i/ is not specified for place.
  - Additive: /i/ is specified for place, but that specification is identifiable as redundant, so it can be ignored by some rules.

4.1 The additive approach

- We might implement the additive approach by (metaphorically) painting redundant features blue.
  - Some rules can see both contrastive features and redundant ones.
  - Other rules can see contrastive features, but not redundant ones.
- But Halle, Vaux & Wolfe's (2000) analysis of derived transparency in Uyghur shows that the additive approach has to be more complicated than that.
- We can't just paint redundant features once and for all; features' contrastive status has to be reassessed during the course of the derivation, as in Figure 1.

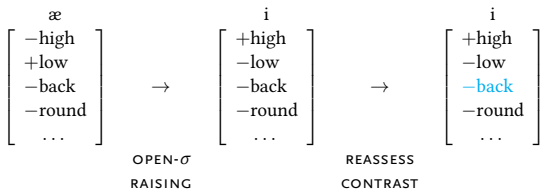


Figure 1: Schematic derivation of transparent raised [i] in the additive approach

- The status of a feature can't be read from the representation.
- It must be assessed based on the inventory, or on the marking statements (Calabrese 1995) that constrain the inventory.

Calculating contrast in the additive approach: How to tell whether you can see [–back] on /i/

(17) Calabrese (1995: 435): Given a language L and the marking statement M [*α*F, *β*G]:

a. [*β*G] and its opposite [−*β*G] are contrastive in a bundle [*α*F, ___] of L if and only if M is deactivated in L.

∴ [±round] is contrastive on (non-low) [−back] segments.

b. [*α*F] is not contrastive in a bundle T [___, −*β*G, *γ*D, ...] of L if [−*β*G] is contrastive in T and there is an active marking statement or prohibition [−*α*F, −*β*G] in L.

(18) Marking statements:

a. [−back, +round] / [___, −low] inactive in Uyghur

b. [+back, −round] / [___, −low] active in Uyghur

∴ [−back] is **not** contrastive on (non-low) [−round] segments.

4.2 The subtractive approach

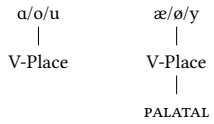
- The additive approach requires rules to consult marking statements to know what features to ignore.
- But the Uyghur facts potentially present a challenge for a subtractive approach, too.
- In the subtractive approach, redundant features are underlyingly absent (not just blue).
- Underlying /æ/ must be specified for place, since it participates in harmony and contrasts with /ɑ/.
- Is there a principled explanation for the fact that raising /æ/ to [i] makes it transparent to harmony?
- Yes: As D'Arcy (2004) points out, raising neutralizes the underlying contrast between /æ/ and /ɑ/.
- Raising is reduction, in two senses:
  - Acoustic: Raising reduces the sonority of the affected vowels.
  - Formal: It also reduces their featural content.
- Raising/reduction neutralizes /æ/ and /ɑ/ to [i] not by imposing frontness, but by deleting place altogether.

5 Implementing the subtractive account

5.1 Contrastive representations

- In the subtractive approach, neutral vowels lack specifications for place.
- For non-neutral vowels, we want to be able to say that back is the default place, but we also need to be able to distinguish default place from lack of place.
- The representations in (19) accomplish this with privative features in a dependency structure.

(19)



- These can be assigned by Dresher's (2009) Successive Division Algorithm in either of two ways:
  - The V-Place node could be treated as an abstract contrastive feature that distinguishes harmonic vowels from neutral vowels (as Hall 2007 does with Laryngeal for consonants).
  - Alternatively, V-Place can be treated as an organizing node that does not itself mark contrasts, but that is present on all and only the segments in which the presence or absence of its dependent feature PALATAL is contrastive (Sandstedt 2018a,b; cf. the Node Activation Condition of Avery & Rice 1989).

5.2 Harmony and transparency

- Alternating suffix vowels have bare V-Place nodes. Harmony causes a PALATAL feature in a root to be shared by suffixal vowels with V-Place, ignoring any intervening neutral vowels.

(20)

→ køl-imiz-gæ (7b)

- If the root has no PALATAL feature to spread, the suffix vowels surface as back by default. This will be the case if the root vowels are back, as in (21), or neutral, as in (22).

(21)

→ jol-imiz-ʁɑ (8b)

(22)

→ sinip-qɑ (10a)

- Neutral-vowel roots that (exceptionally) take front suffixes have a floating PALATAL feature, as in (23).

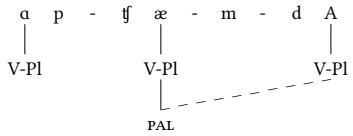
(23)

→ bilim-gæ (9a)

5.3 Derived transparency

- The suffix *-ʧæ* has its own PALATAL feature, which it can share with subsequent suffixes.

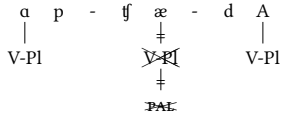
(24)



→ kitɑp-ʧæ-m-dæ (14b)

- Raising/reduction deletes the place features of the raised vowel. When this applies to *-ʧæ*, subsequent suffixes will be back by default if there is no PALATAL feature in the root, as in (25).

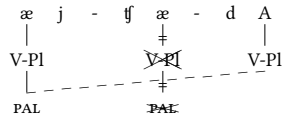
(25)



→ kitɑp-ʧi-dɑ (16b)

- But if the root has a front-harmonic vowel, then its PALATAL feature can be shared with the suffix, as in (26).

(26)



→ næj-ʧi-dæ (16a)

- Because raising/reduction neutralizes the place distinction between /æ/ and /ɑ/, it is natural to represent it as deleting place features.
- This correctly derives the transparency of the raised vowel in examples like (25) and (26), without having to say that the phonological computation needs to refer to marking statements to determine which features it should attend to.

6 Extending the subtractive account

6.1 Disharmonic roots

- Halle, Vaux & Wolfe (2000: 397–399) argue that the subtractive approach (which they refer to as "prespecification") incorrectly predicts that [i] derived from a harmonic low vowel could retain its harmonic feature:

> In the prespecification analysis […], the transparency of the raised output of *-ʧæ-* requires postulation of an ad hoc rule that deletes the [−back] specification of the *i*. The problem here is that the prespecification analysis misses the connection between *i* that results from Raising and *i* that comes from underlying *i* […].
>
> Our theory […] predicts that there is no language that is exactly like Uyghur, save that the output of raising a disharmonic suffix remains disharmonic.

- The word "suffix" turns out to be crucial to the validity of their prediction.
- As Vaux (2000) discusses in more depth, Uyghur has some disharmonic roots, such as those in (27) and (28).

(27) Front–back roots

a.	æswɑp	'tool'
b.	qæhwɑ	'coffee'
c.	æmmɑ	'but'
d.	ændʒɑn	'Änjan' (personal name)

(28) Back–front roots

a.	ɑdæm	'man'
b.	ɑʁinæ	'friend'
c.	ɑpæt	'disaster'
d.	roʃæn	'Roshän' (personal name)

- In contexts where their second vowel is raised/reduced to [i], front–back roots like those in (27) show the expected pattern of derived transparency: the frontness of the first root vowel is shared with harmonizing suffixes, as in (29); data from Vaux (2000).

(29)

a.	æswib-i-ɣæ	'tool'+3SG.POSS+DAT.
b.	qæhwi-ɣæ	'coffee'+DAT.
c.	æmmi-lær	'but'+PL.
d.	ændʒin-i-ɣæ	'Änjan'+3SG.POSS.+DAT.

- But back–front roots like those in (28) also take front suffixes when their second vowels undergo raising/reduction, as in (30); data from Vaux (2000).

(30)

a.	ɑdim-i-ɣæ	'man'+3SG.POSS.+DAT.
b.	ɑʁini-lær	'friend'+PL.
c.	ɑpit-i-ɣæ	'disaster'+3SG.POSS.+DAT.
d.	roʃin-i-ɣæ	'Roshän'+3SG.POSS.+DAT.

- Here, it looks as if the underlying frontness of the second vowel is retained even under raising/reduction.
- Vaux (2000), working with the same approach to contrast as Halle, Vaux & Wolfe (2000), accounts for this through rule ordering. Vowel harmony applies cyclically, then raising applies post-cyclically, then harmony applies again post-cyclically.
  - Forms like (30) show front suffixes because cyclic harmony applies before raising.
  - Forms like (16b) *kitap-tʃi-da* show back suffixes because *-tʃæ* is non-cyclic, so raising bleeds harmony.
- A similar account would also be compatible with the representations we've posited.
- But our representations don't require a system in which harmony applies both before and after raising.
- Instead, they—and our approach to contrast more generally—offer an elegant and principled account of the Uyghur facts that is not dependent on one particular model of the computational system.

6.2 Root faithfulness

- There are two principal asymmetries to account for:
  - Front vowels vs. back vowels: In both (29) and (30), a front root vowel wins out over a back one in determining the place of the suffix vowel.
  - Roots vs. suffixes: When suffixal /æ/ raises, its frontness is lost, as in (16b); when root /æ/ raises, its frontness can be preserved on a suffix, as in (30).
- The representations in (19), repeated in (31), generate the front–back asymmetry: front vowels have more marked structure.

(31)

i/e	ɑ/o/u	æ/ø/y
	V-Place	V-Place
		PALATAL

- The root–suffix asymmetry can be understood in terms of root faithfulness (Beckman 1998: ch. 4).
- Root faithfulness is most easily formalized in Optimality Theory, following Beckman, but could also be adapted into a rule-based framework. (See, e.g., Dresher & van der Hulst 1998, though their focus is on prosodic rather than morphological headedness.)
- We present below an OT account of Uyghur vowel harmony based on the representations in (31); see Mackenzie & Dresher (2003) for discussion of how contrastive specification can be implemented in OT.
- An overview of how the patterns are derived:
  - Raising/reduction delinks V-Place.
  - When this happens to a root vowel with a PALATAL feature, root faithfulness will preserve the PALATAL feature by associating it to a suffixal V-Place node if possible.
  - A stranded PALATAL feature from a raised/reduced suffix vowel is not protected by root faithfulness, and is simply deleted.
- The relevant constraints are shown in (32). Horizontal lines indicate where one constraint or set of constraints crucially outranks another.

(32)

a. DEPLINK[PAL]/ROOT: If PALATAL is linked to a vowel in the root in the output, then PALATAL must be linked to a corresponding vowel in the input.
≈Don't add a PALATAL link within the root.

b. *GAP: PALATAL may not be linked to non-consecutive V-Place nodes.
≈Don't skip vowels when spreading PALATAL.

c. *FLOAT: All features must be associated to a segment.
≈No floating features.

d. REDUCE: V-Place is not licensed on unrounded vowels in medial light syllables.
≈Uyghur raising happens.

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e. MAXLINK[PAL]: If PALATAL is linked to a vowel in the input, then PALATAL must be linked to a corresponding vowel in the output.
≈Don't delete a PALATAL link.

f. MAX-IO[PAL]/ROOT: A PALATAL feature in the root in the input has a correspondent in the output.
≈Don't delete a PALATAL feature from the root.

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g. ALIGN[PAL]-RIGHT: Assign a violation mark for each V-Place node that intervenes between the rightmost anchor of a PALATAL specification and the right edge of the word.
≈Spread PALATAL rightwards.

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h. DEPLINK[PAL]: If PALATAL is linked to a vowel in the output, then PALATAL must be linked to a corresponding vowel in the input.
≈Don't add a PALATAL link.

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i. MAX-IO[PAL]: A PALATAL feature in the input has a correspondent in the output.
≈Don't delete a PALATAL feature.

- The tableau in (33) shows how harmony spreads PALATAL from a root to a suffix across transparent /i/. Because /i/ has no V-Place node, it is not relevant for *GAP.

(33) Deriving (7b) *køl-imiz-gæ* 'lake'+'our'+DAT.

	DEPLINK[PAL]/RT	*GAP	*FLOAT	REDUCE	MAXLINK[PAL]	MAX[PAL]/RT	AL[PAL]-R	DEPLINK[PAL]	MAX[PAL]
a. ☞ k ø l - i m i z - G A V-Pl V-Pl PAL								*	
b. k ø l - i m i z - q ɑ V-Pl V-Pl PAL							*!		
c. k o l - i m i z - g æ V-Pl V-Pl PAL					*!			*	
d. k o l - i m i z - q ɑ V-Pl V-Pl					*!	*			*

- Given the ranking in (32), back root vowels will block spreading, as in (34), but raising makes them transparent, as in (35).

(34) Deriving *æswap-qa* 'tool'+DAT.

	DEPLINK[PAL]/RT	*GAP	*FLOAT	REDUCE	MAXLINK[PAL]	MAX[PAL]/RT	AL[PAL]-R	DEPLINK[PAL]	MAX[PAL]
a. ☞ æ s w ɑ p - q ɑ V-Pl V-Pl V-Pl PAL							**		
b. ɑ s w ɑ p - q ɑ V-Pl V-Pl V-Pl					*!	*			*
c. æ s w ɑ p - k æ V-Pl V-Pl V-Pl PAL		*!						*	
d. æ s w æ p - k æ V-Pl V-Pl V-Pl PAL	*!							**	

(35) Deriving (29a) *æswib-i-yæ* 'tool'+3SG.POSS+DAT.

	DEPLINK[PAL]/RT	*GAP	*FLOAT	REDUCE	MAXLINK[PAL]	MAX[PAL]/RT	AL[PAL]-R	DEPLINK[PAL]	MAX[PAL]
a. ☞ æ s w i b - i - ʏ æ V-Pl V-Pl PAL								*	
b. æ s w i b - i - ʁ ɑ V-Pl V-Pl PAL							*!		
c. æ s w ɑ b - i - ʁ ɑ V-Pl V-Pl V-Pl PAL				*!			**		

- A PALATAL feature from a suffix will not be preserved under raising, as shown in (36).

(36) Deriving (16b) *kitap-ʧi-da* 'book'+*ʧæ*+LOC.

	DEPLINK[PAL]/RT	*GAP	*FLOAT	REDUCE	MAXLINK[PAL]	MAX[PAL]/RT	AL[PAL]-R	DEPLINK[PAL]	MAX[PAL]
a. ☞ k i t ɑ p - ʧ i - d ɑ V-Pl V-Pl PAL					*				*
b. k i t ɑ p - ʧ i - d æ V-Pl V-Pl PAL					*			*!	
c. k i t ɑ p - ʧ æ - d æ V-Pl V-Pl V-Pl PAL				*!				*	

- But a PALATAL feature from a root will be realized on a suffix even if raising/reduction prevents it from surfacing on the root vowel, as in (37).

(37) Deriving (30a) *adim-i-yæ* 'man'+3SG.POSS.+DAT.

ɑ d æ m - i - G A V-Pl V-Pl V-Pl PAL	DepLink[PAL]/RT	*Gap	*Float	Reduce	MaxLink[PAL]	Max[PAL]/RT	Al[PAL]-R	DepLink[PAL]	Max[PAL]
a. ☞ ɑ d i m - i - ɣ æ V-Pl V-Pl PAL					*			*	
b. ɑ d i m - i - ʁ ɑ V-Pl V-Pl					*	*!			*
c. ɑ d æ m - i - ɣ æ V-Pl V-Pl V-Pl PAL				*!				*	
d. ɑ d æ m - i - ʁ ɑ V-Pl V-Pl V-Pl PAL				*!			*		
e. ɑ d i m - i - ʁ ɑ V-Pl V-Pl PAL			*!		*				
f. æ d i m - i - ɣ æ V-Pl V-Pl PAL	*!				*			**	

7 Conclusions

- Representations in which only contrastive features are specified can account for the Uyghur patterns, and do so without requiring the phonological computation to refer to marking statements to determine which features are visible.
- Halle, Vaux & Wolfe's (2000) prediction "that there is no language that is exactly like Uyghur, save that the output of raising a disharmonic suffix remains disharmonic" is not really very strong—in Vaux's (2000) system, ordering post-cyclic vowel harmony before raising would produce the same effect.
- The representations proposed here account for the transparency of the neutral vowels and for the asymmetry between front and back harmonic vowels.
- Operating on these representations, the phonological computation can account for the root–suffix asymmetry either through root faithfulness, as shown here, or through cyclic rule application, as in Vaux's account.

- Other things our representations should be able to handle (but which we don't have time to present here):
  - Umlaut: In initial open syllables, /æ/ and /ɑ/ raise to [e] if the next syllable contains [i]—excluding [i] derived by reduction, but including epenthetic [i].
    - As our account of reduction leads us to expect, umlaut does not affect harmony: umlauted root /æ/ is followed by front suffixes, umlauted root /ɑ/ by back ones (Hahn 1991a: 51–52).
  - Vowel–consonant interactions: A dorsal consonant will be either velar or uvular, according to…
    - …its underlying specification, if it's in a root, otherwise
    - …whether the immediately preceding dorsal consonant (if any) is velar or uvular, otherwise
    - …whether the following vowel is front or back.

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