Vilnius
University

XYZ-effects in phonology and beyond

Translation of a workshop talk

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2021-10-29

Features with and without XYZ-effects

Feature	**Input segments**	**Effect valid?**	**Effect productive?**
Presence in lexicon	Phonemes	No	–
Phonological well-formedness	Phonemes	Yes	Yes
Morphological well-formedness	Morphemes	Yes	No
Syntactic well-formedness	Words	Yes	No

No XYZ-effects for presence in lexicon

Premises:

- *spill* is a word
- *sow* is a word
- *pillow* is a word

Conclusion:

- *spillow* is a word

Here, the argument is absurd and the conclusion false.

	X	Y	Z
XY	s	pill	
XZ	s		ow
YZ		pill	ow
XYZ	s	pill	ow

Features with and without XYZ-effects

Feature	Input segments	Effect valid?	Effect productive?
Presence in lexicon	Phonemes	No	–
Phonological well-formedness	Phonemes	Yes	Yes
Morphological well-formedness	Morphemes	Yes	No
Syntactic well-formedness	Words	Yes	No

XYZ-effects for phonological well-formedness

Premises:

- *spill* is well-formed
- *sow* is well-formed
- *pillow* is well-formed

Conclusion:

- *spillow* is well-formed

Now, the conclusion **is true**: it is a phonologically well-formed pseudo-word. The argument **might be valid**!

	X	**Y**	**Z**
XY	s	pill	
XZ	s		ow
YZ		pill	ow
XYZ	s	pill	ow

Artificial example

Premises:

- *isom* is well-formed
- *isi* is well-formed
- *somsi* is well-formed

Conclusion:

- *isomsi* is well-formed

	X	**Y**	**Z**
XY	i	som	
XZ	i		si
YZ		som	si
XYZ	i	som	si

Simulation with artificial lexicon

XY	XZ	YZ	XYZ
mi	mumi	iumi	miumi
imu	imi	mumi	imumi
imemei	imu	memeimu	imemeimu
ɪmai	ɪmamu	imu	ɪmaimu
ɪmai	ɪmamemu	imemu	ɪmaimemu
ɪmai	ɪmame	ime	ɪmaime
ɪmama	ɪmama	mama	ɪmamama
ma	mamʊ	aamʊ	maamʊ
mɪma	mu	ɪmau	mɪmau
mɪma	mi	ɪmai	mɪmai
mɪma	ma	ɪmaa	mɪmaa
mɪma	mɪma	mama	mɪmama
mɪma	mɪmʊ	mamʊ	mɪmamʊ
imemu	imemi	mumi	imemumi

Simulation with artificial lexicon

XY	XZ	YZ	XYZ
mi	mumi	iumi	miumi
imu	imi	mumi	imumi
imemei	imu	memeimu	imemeimu
ɪmai	ɪmamu	imu	ɪmaimu
ɪmai	ɪmamemu	imemu	ɪmaimemu
ɪmai	ɪmame	ime	ɪmaime
ɪmama	ɪmama	mama	ɪmamama
ma	mamʊ	aamʊ	maamʊ
mɪma	mu	ɪmau	mɪmau
mɪma	mi	ɪmai	mɪmai
mɪma	ma	ɪmaa	mɪmaa
mɪma	mɪma	mama	mɪmama
mɪma	mɪmʊ	mamʊ	mɪmamʊ
imemu	imemi	mumi	imemumi

Generic shape of XYZ-effects

Inputs:

- XY
- XZ
- YZ

Output:

- XYZ

When do **phonological** XYZ-effects hold?

At least when any of the following is present:

- local constraints,
- initial and/or final constraints,
- vowel/consonant harmonies:
  - single or multiple
  - with transparent segments
  - with blockers: regular or circumambient
  - with conditional blockers (?)
  - with icy targets (?)
  - parasitic (?)
- long-distance assimilation,
- quantification, e. g. “exactly 1 unreduced vowel”.

...universally?

Arguments in favor of universality

Local, initial, and final constraints

To be argued schematically

Typology of harmony systems

References: Rose & Walker (2011), Jurgec (2011), Aksënova et al. (2020), Aksënova & De Santo (2021), Burness et al. (2021), and others

Examples: Finnish (< Finnic), Imdlawn Tashlhiyt (< Berber), Tutrugbu (< Atlantic-Congo)

Computational simulations

Counterexamples welcome!

Outline

1. Local, initial, and final constraints
2. Finnish vowel harmony (“classical” harmony)
3. Imdlawn Tashlhiyt consonant harmony (with blockers)
4. Tutrugbu vowel harmony (with circumambient blockers)
5. Morphology
6. Syntax
7. Induction procedure based on the XYZ-effects

Local phonological constraints

Constraint: **Lithuanian (< Balto-Slavic)**

Clusters of adjacent consonants must be **all** palatalized, or **all** plain.

= **Pairs** of adjacent consonants must be **both** palatalized, or **both** plain.

Licit:

ʒʲ vʲ ɪ lʲ kʲ sʲ nʲ ɪ s

ʒʲ vʲ ɛ l k s

Illicit:

* ʒʲ vʲ ɛ lʲ k s locus of violation

Loci of violation

- Must unambiguously signal a violation even when deprived of its phonological context
- The defining feature of local phonological constraints (local phonotactics)
- Typology suggest that loci are always **1, 2,** or **3** phonemes wide, not more
- We will also use the word “locus” where **no violation** is implied

Loci in *spillow*

spɪl + soʊ + pɪloʊ → spɪloʊ

spɪloʊ

spɪl pɪloʊ

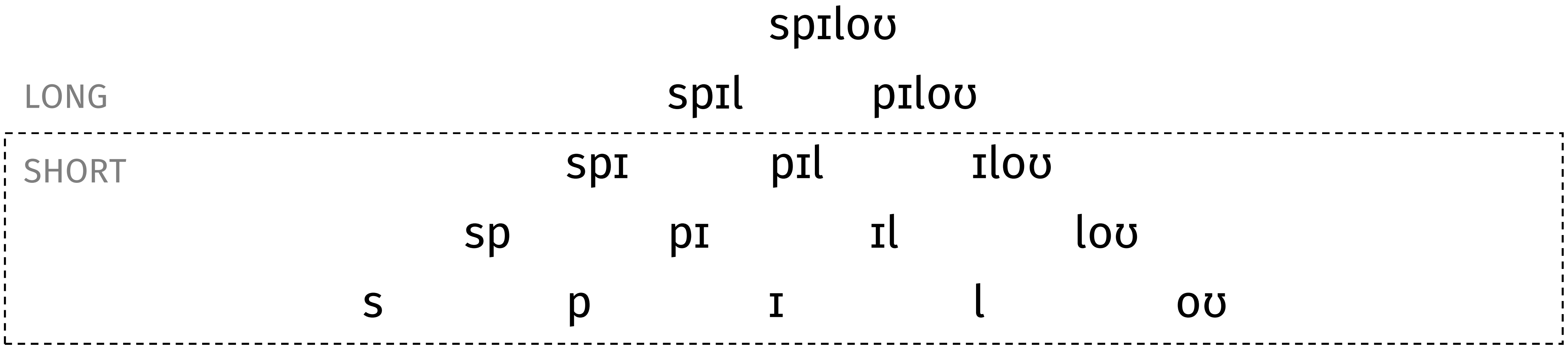
spɪ pɪl ɪloʊ

sp pɪ ɪl loʊ

s p ɪ l oʊ

Loci in *spillow*

spɪl + soʊ + pɪloʊ → spɪloʊ



spɪloʊ

LONG

spɪl pɪloʊ

SHORT

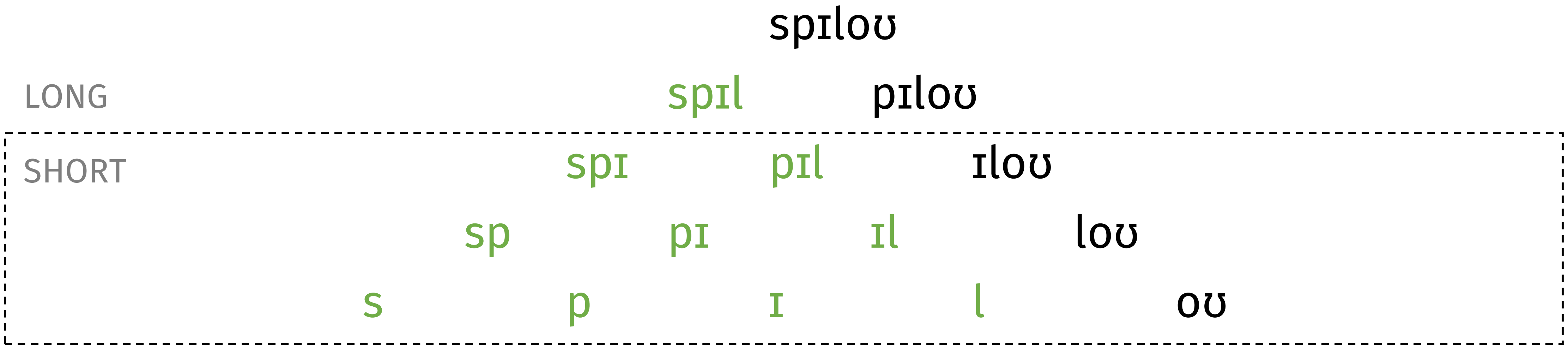
spɪ pɪl ɪloʊ

sp pɪ ɪl loʊ

s p ɪ l oʊ

Loci in *spillow*, inherited from *spill* (XY)

spɪl + soʊ + pɪloʊ → spɪloʊ



spɪloʊ

LONG

spɪl pɪloʊ

SHORT

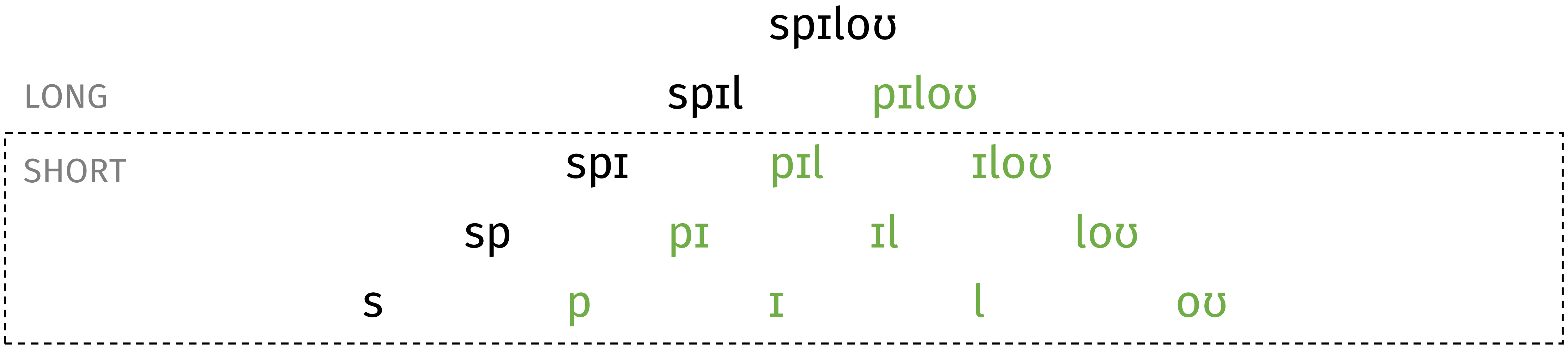
spɪ pɪl ɪloʊ

sp pɪ ɪl loʊ

s p ɪ l oʊ

Loci in *spillow*, inherited from *pillow* (YZ)

spɪl + soʊ + pɪloʊ → spɪloʊ



spɪloʊ

LONG

spɪl pɪloʊ

SHORT

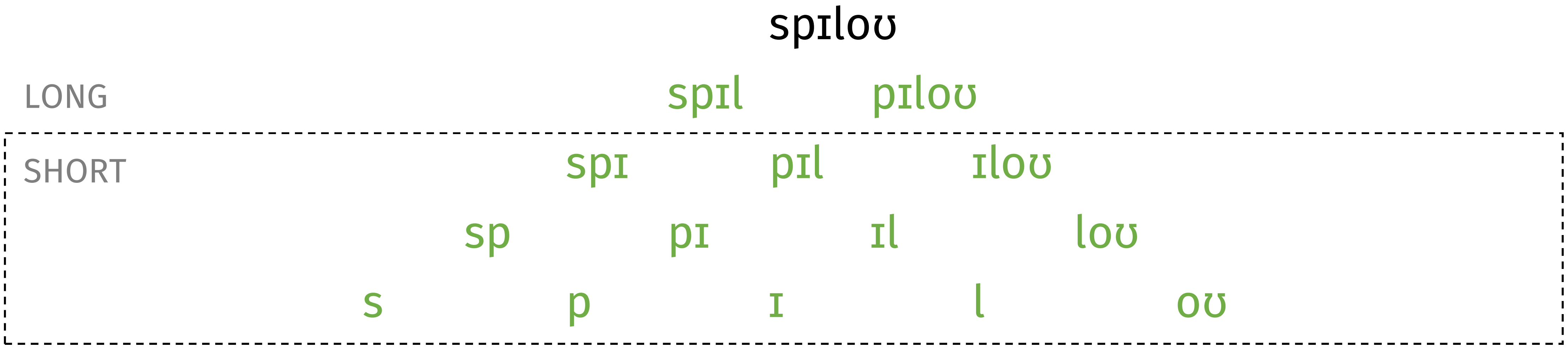
spɪ pɪl ɪloʊ

sp pɪ ɪl loʊ

s p ɪ l oʊ

Loci in *spillow*, inherited from XY **or** YZ

spɪl + soʊ + pɪloʊ → spɪloʊ



spɪloʊ

LONG

spɪl pɪloʊ

SHORT

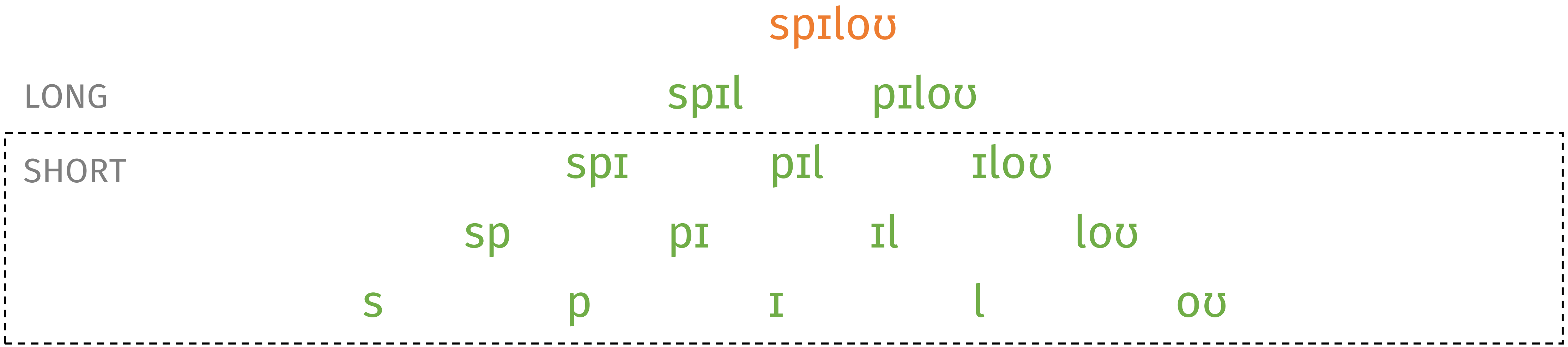
spɪ pɪl ɪloʊ

sp pɪ ɪl loʊ

s p ɪ l oʊ

New, non-inherited loci in *spillow*

spɪl + soʊ + pɪloʊ → spɪloʊ



spɪloʊ

LONG

spɪl pɪloʊ

SHORT

spɪ pɪl ɪloʊ

sp pɪ ɪl loʊ

s p ɪ l oʊ

Conclusion on loci of violation

- **All short** loci are **inherited**, and thus contain no violations
- Only long loci form newly; concretely, only ones longer than XY, XZ, or YZ
- Only these loci could theoretically contain violations
- Short (bi-phonemic) inputs pose a potential threat for universality
- Unclear if any counterexamples can actually be derived from this

? **Czech:**

	X	**Y**	**Z**	
XY	m	hm		‚uh-huh‘ (periphery!)
XZ	m		ota	‚?‘
YZ		hm	ota	‚matter‘
XYZ	m	hm	ota	

Initial and final constraints

- The **output** XYZ begins with the same phonemes, as the **input** XY already did
- The **output** XYZ ends with the same phonemes, as the **input** YZ already did

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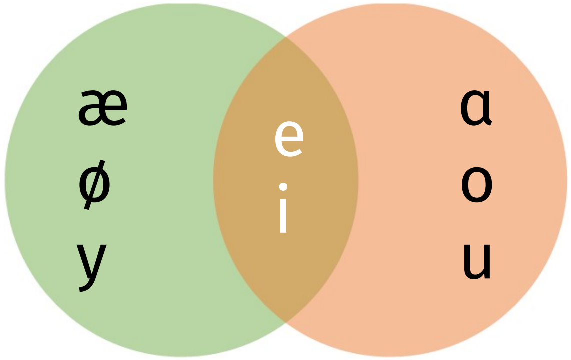
Finnish vowel harmony

Some numerals:

kɑksi	‚2‘	kɑhdeksɑn	‚8‘
yksi	‚1‘	yhdeksæn	‚9‘



Rule: do not mix green and orange vowels in one word

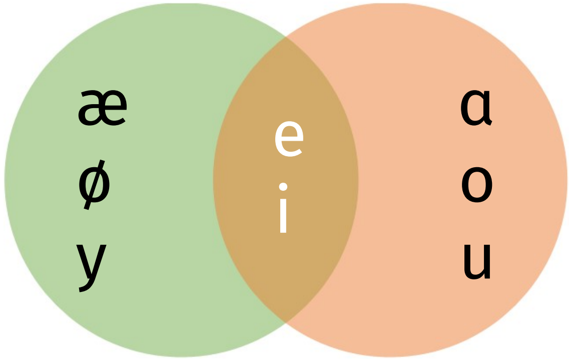
Finnish vowel harmony

Some numerals:

kɑksi	‚2‘	kɑhdeksɑn	‚8‘
yksi	‚1‘	yhdeksæn	‚9‘

kæksi	‚?‘
uksi	‚?‘

pseudo-words



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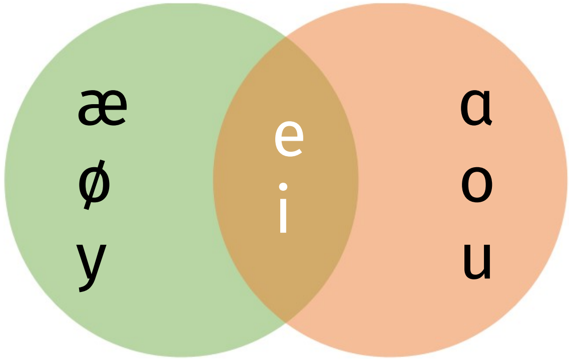
kæksi	‚?‘	*kɑhdeksæn	–
uksi	‚?‘	*yhdeksɑn	–

ill-formed

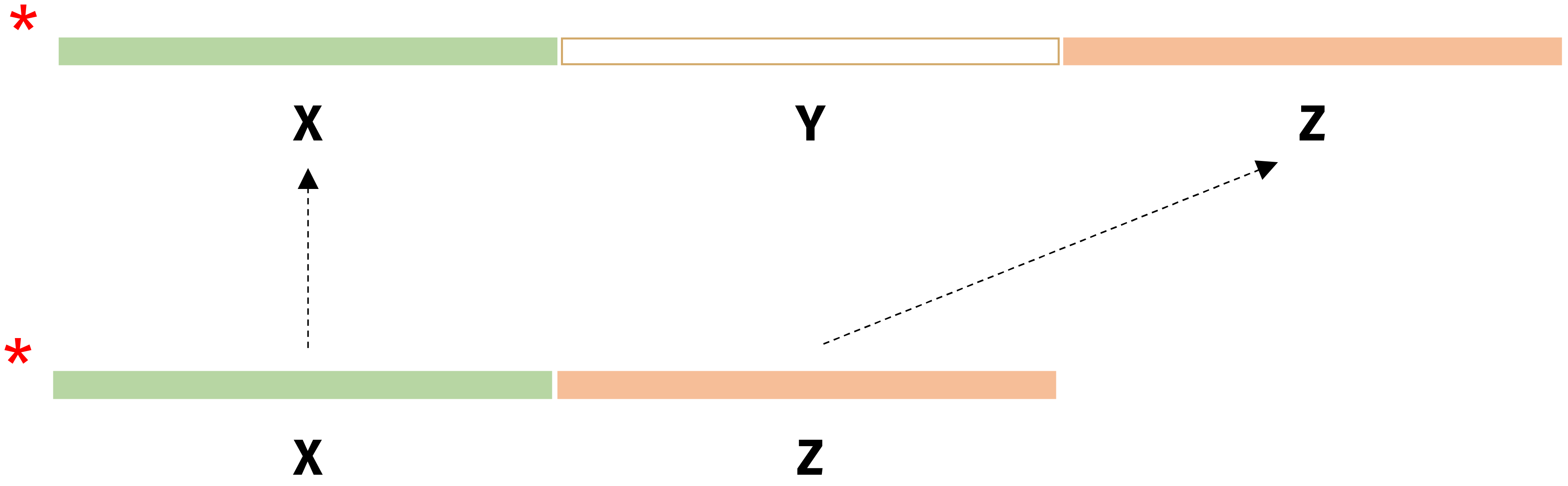
pseudo-words



Rule: do not mix green and orange vowels in one word

Finnish-style harmonies and XYZ-effects

Disharmony in the **output** can only follow from disharmony in an **input**:



26 more combinations for an exhaustive demonstration ☺

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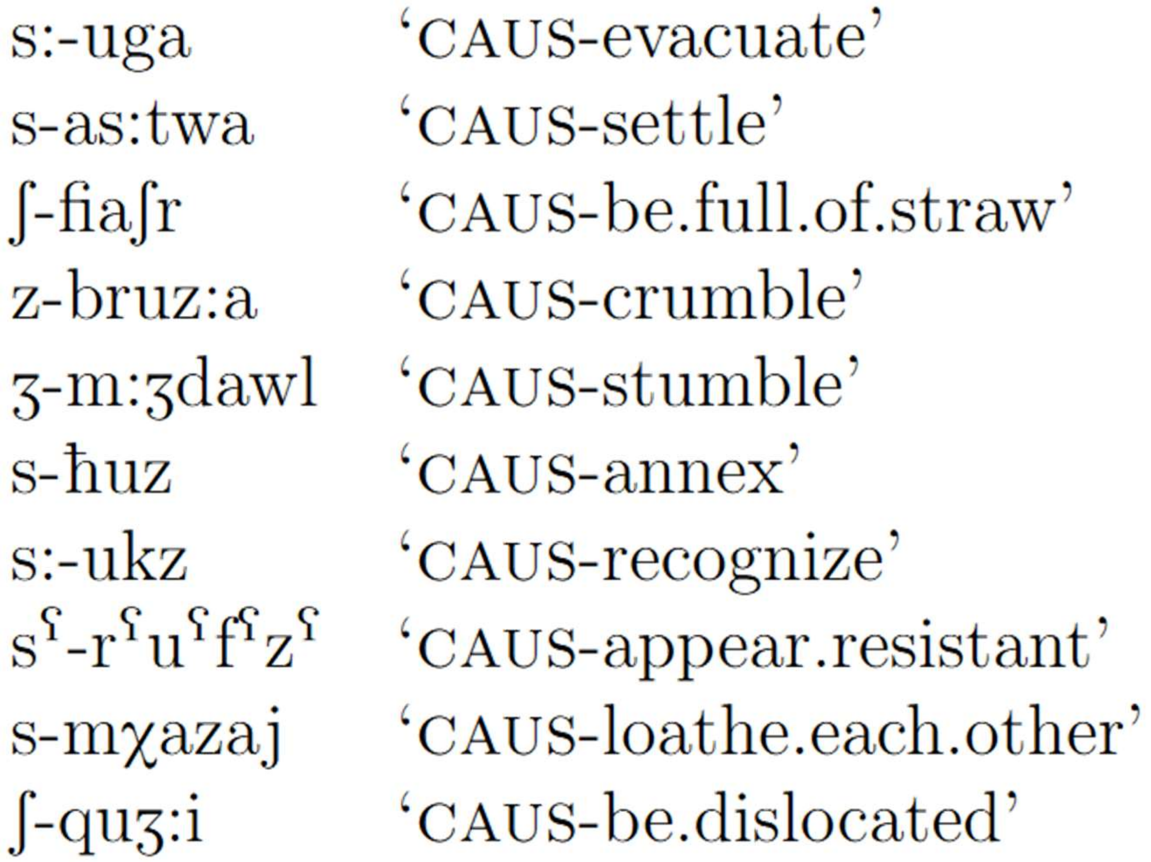
Three harmonies in Imdlawn Tashlhiyt



s:-uga	‘CAUS-evacuate’
s-as:twa	‘CAUS-settle’
ʃ-fiaʃr	‘CAUS-be.full.of.straw’
z-bruz:a	‘CAUS-crumble’
ʒ-m:ʒdawl	‘CAUS-stumble’
s-ħuz	‘CAUS-annex’
s:-ukz	‘CAUS-recognize’
sˤ-rˤuˤfˤzˤ	‘CAUS-appear.resistant’
s-mχazaj	‘CAUS-loathe.each.other’
ʃ-quʒ:i	‘CAUS-be.dislocated’

(Elmedlaoui 1992; Hansson 2010),
reproduced here from (Aksënova et al. 2020)

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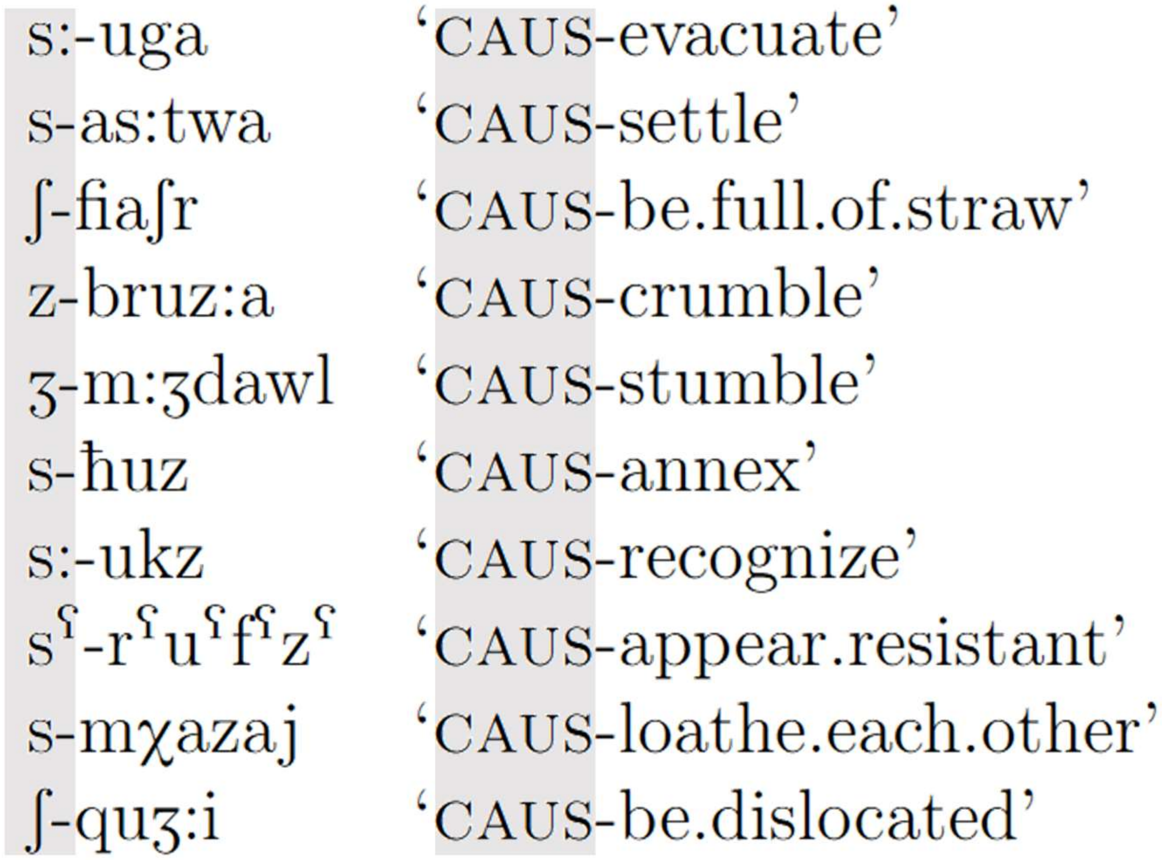

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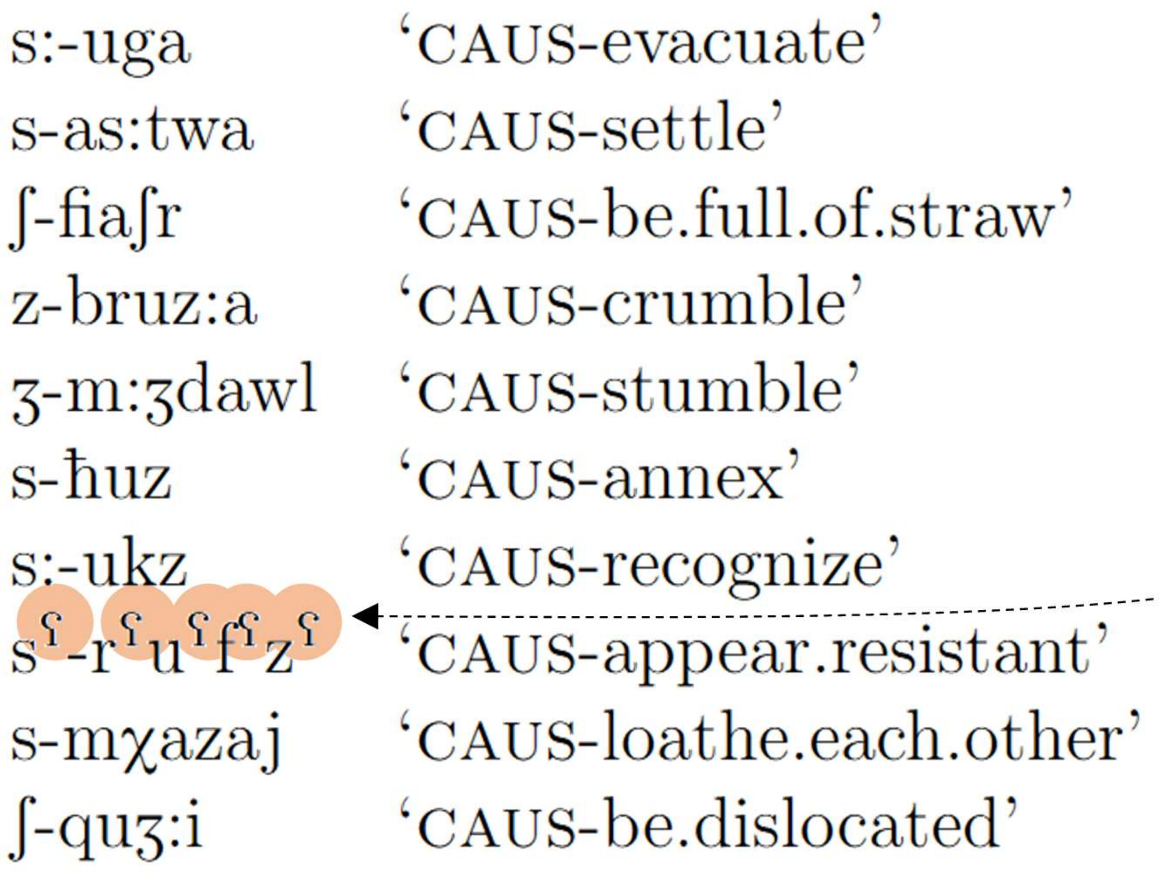

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emphasis
(pharyngealization)
harmony

(Elmedlaoui 1992; Hansson 2010),
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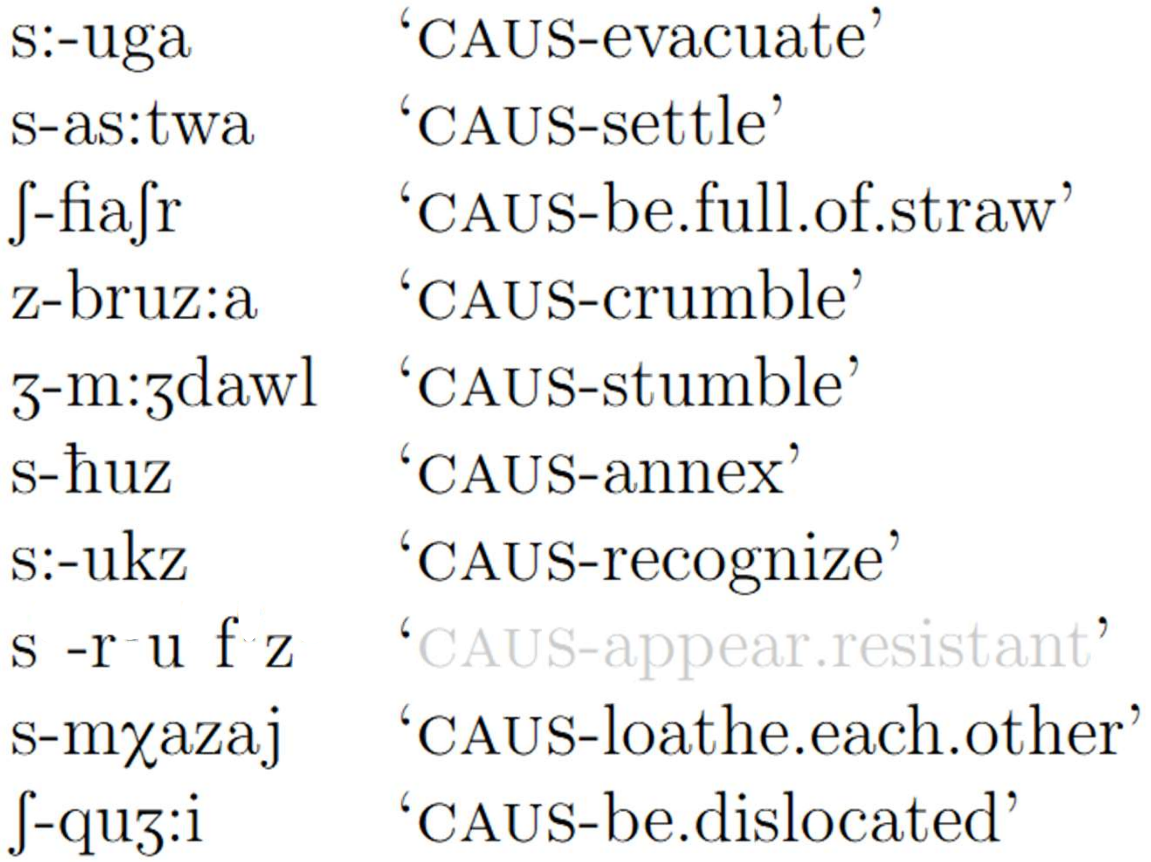
Two harmonies in Imdlawn Tashlhiyt



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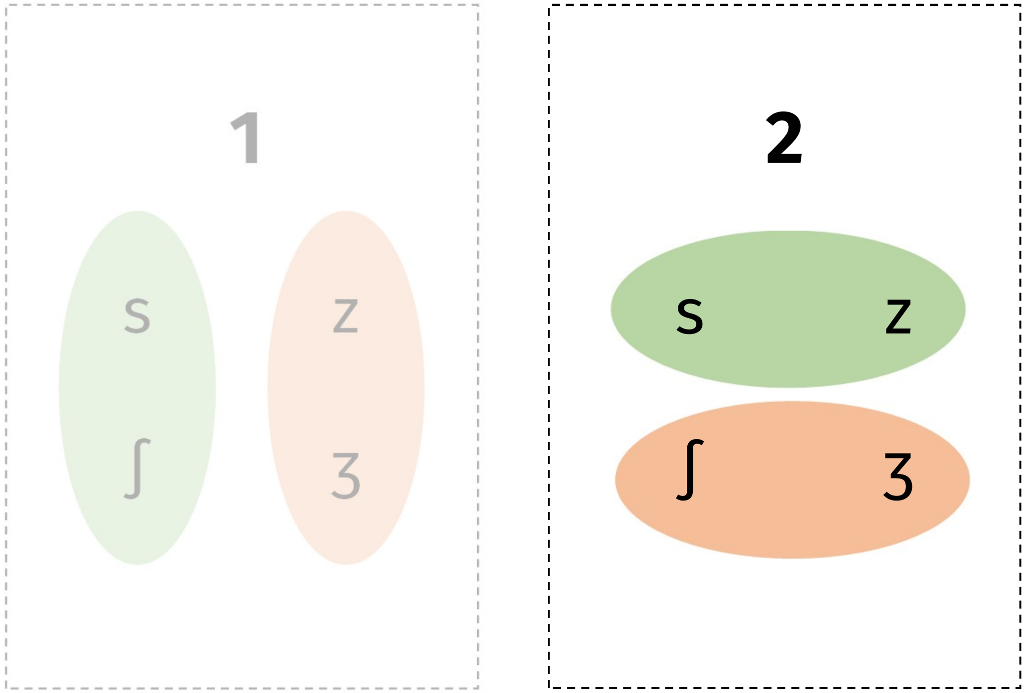

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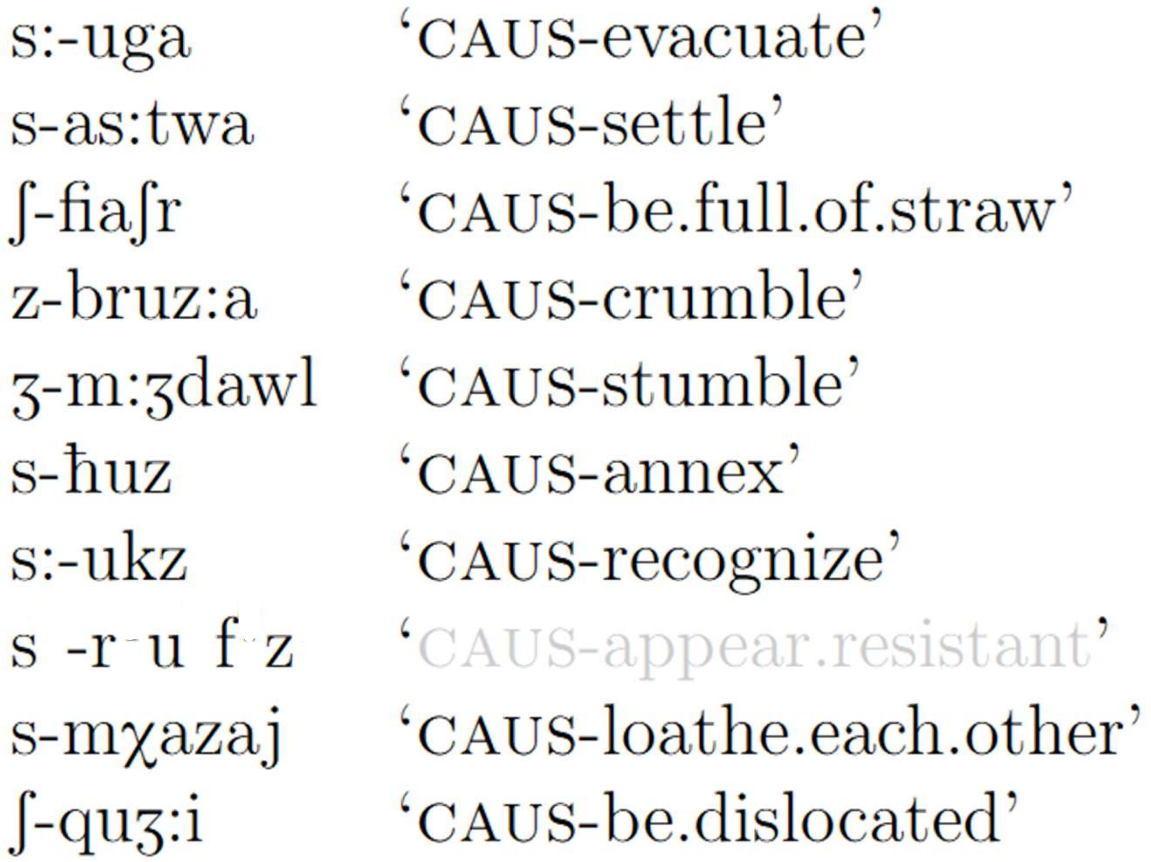

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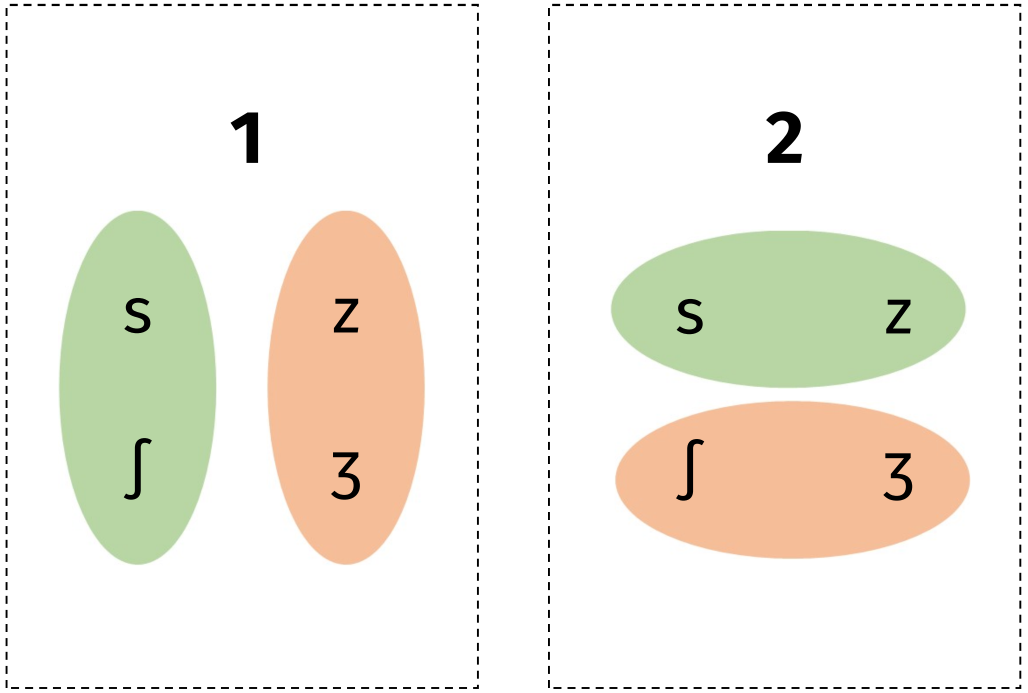

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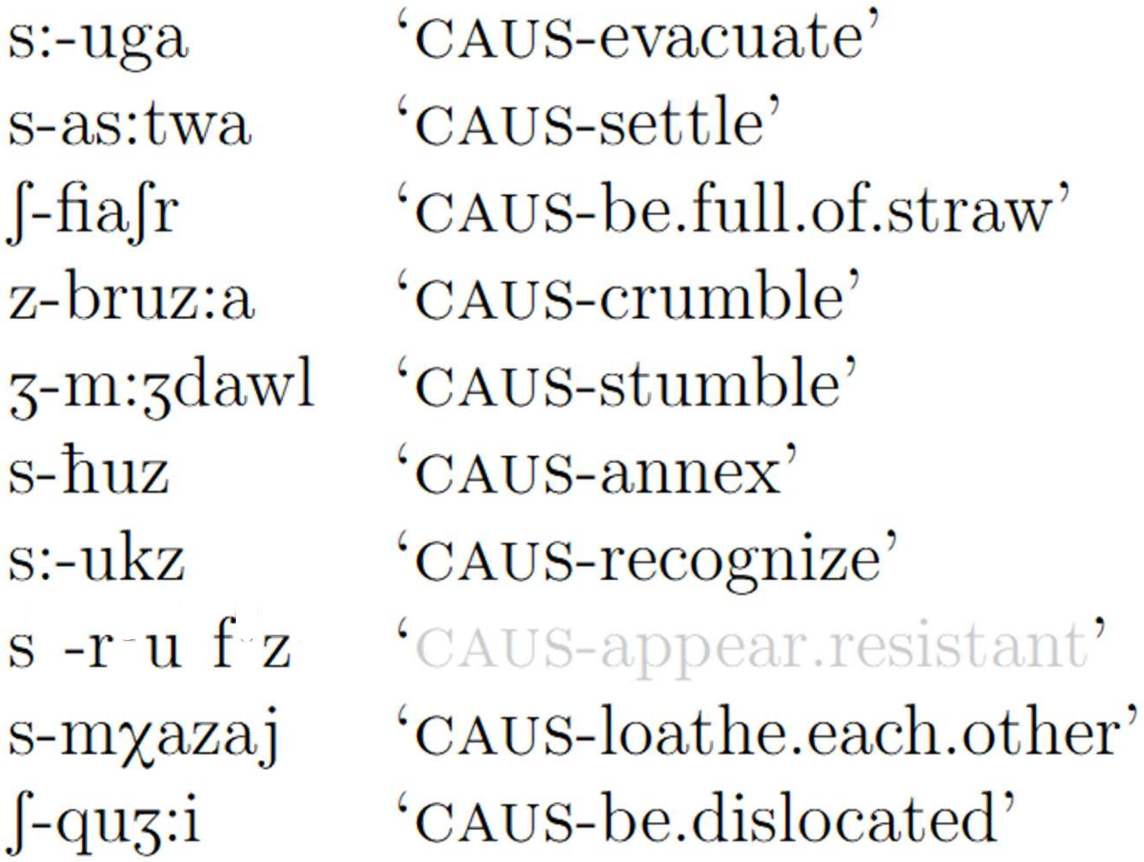
One harmony in Imdlawn Tashlhiyt



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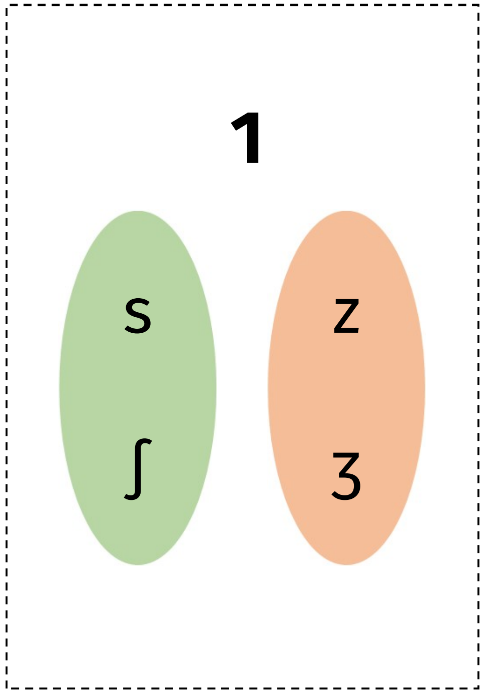

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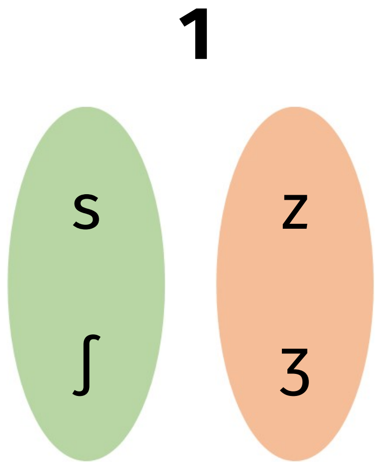

Blockers:
ħ, q, k, χ, f

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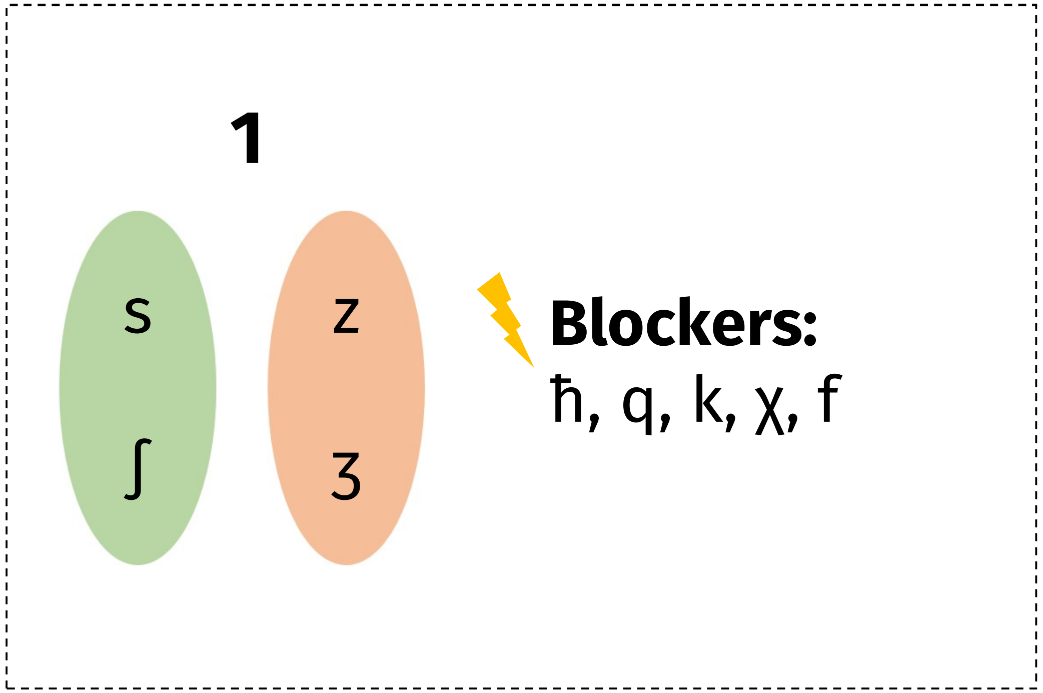

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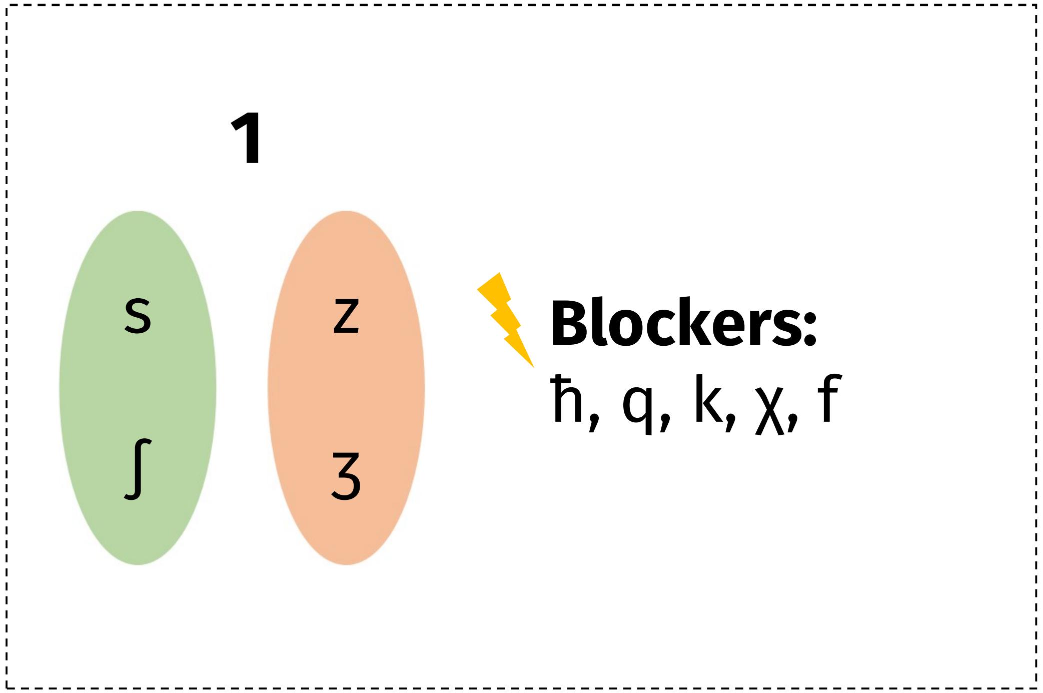
One harmony in Imdlawn Tashlhiyt

s a s: t w a

ʒ m: ʒ d a w l

s m ⚡χ a z a j

*s m a z a j



⚡ **Blockers:**
ħ, q, k, χ, f

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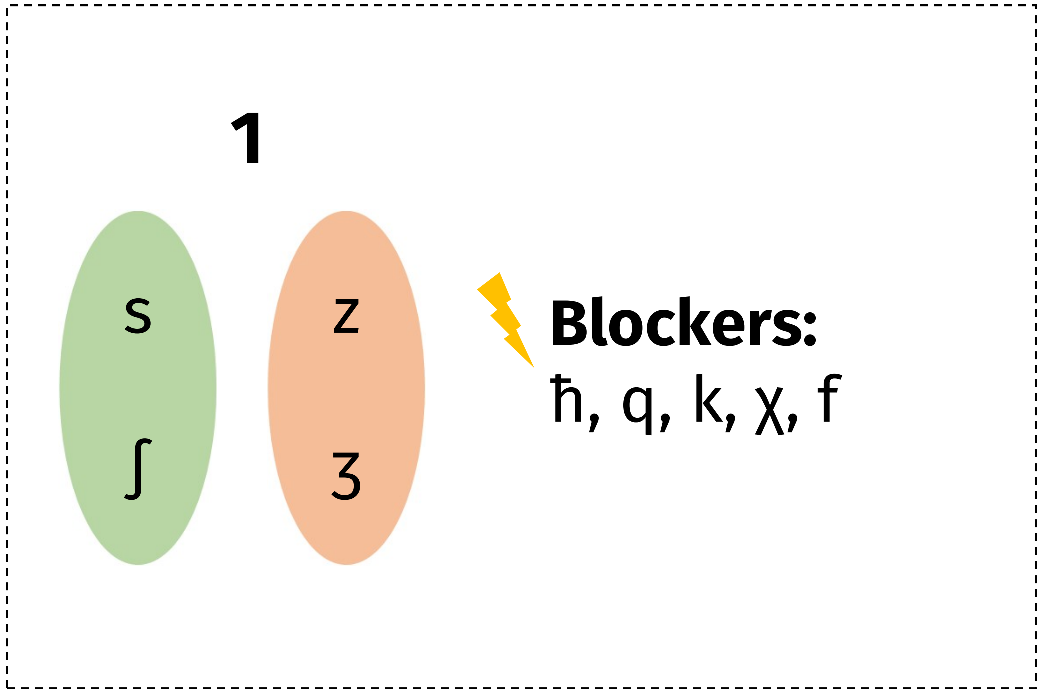


1

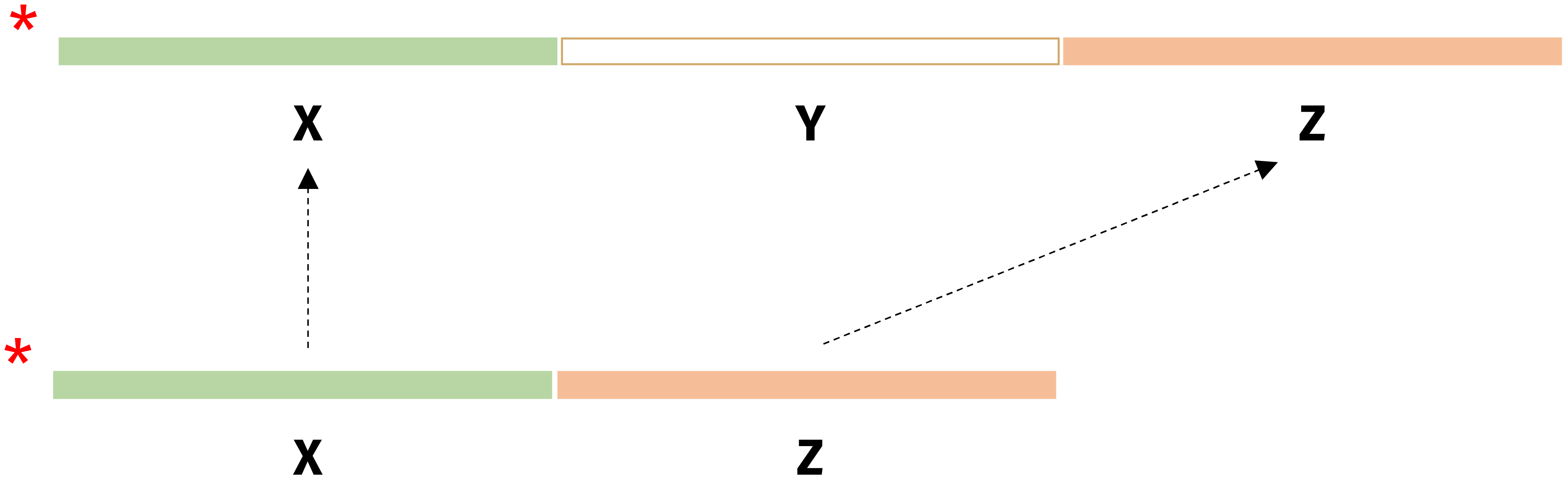
s ʃ

z ʒ

Blockers:
ħ, q, k, χ, f

Recall the “Finnish argument”

Disharmony in the **output** can only follow from disharmony in an **input**:



26 more combinations for an exhaustive demonstration ☺

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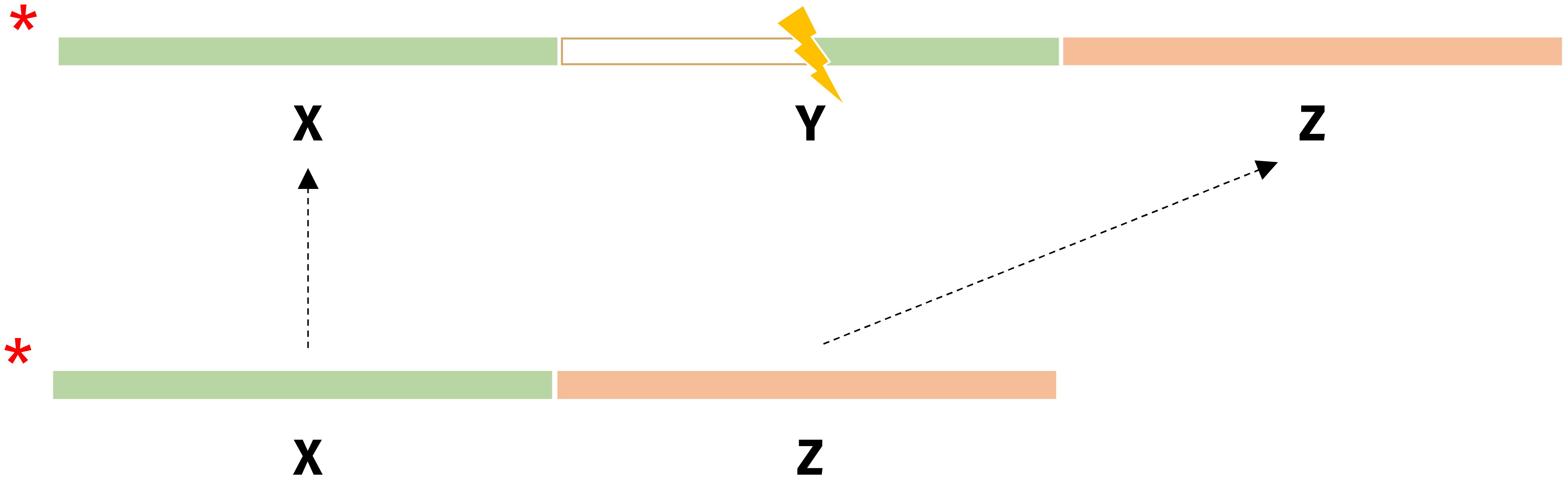

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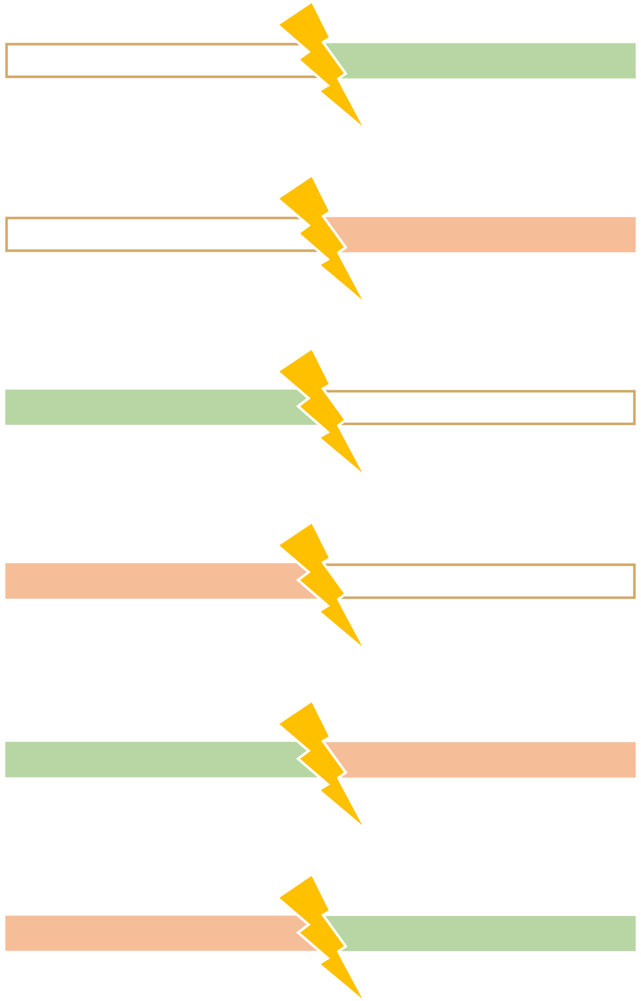

Input pieces now come in 6 new types!

The number of combinations has soared to $(3 + 6)^3$ = **729**, but the argument has remained the same in its essence ☺

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Some points on Tutrugbu harmony

- Vowels: /e i u/ **vs.** /a ɪ ʊ/
  - Others exist but are not relevant here
- Blockers
  - Not always operational
- 2 types of words
  - **A:** initial syllable has a [−high] vowel
  - **B:** initial syllable has a [+high] vowel
- Type A
  - Blockers do not operate – **the harmony encompasses the entire word**
- Type B
  - Blockers **do** operate

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  - Blockers **do** operate

A blocker that comes in two halves?

- Vowels: /e i u/ **vs.** /a ɪ ʊ/
  - Others exist but are not relevant here
- Blockers
  - Not always operational
- 2 types of words
  - **A:** initial syllable has a [−high] vowel
  - **B:** initial syllable has a [+high] vowel **(½ of a blocker)**
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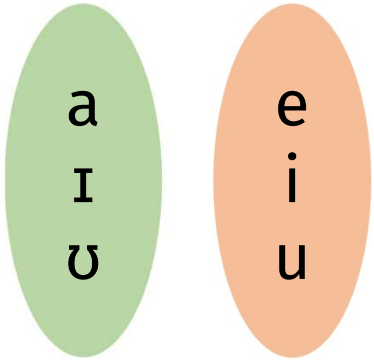
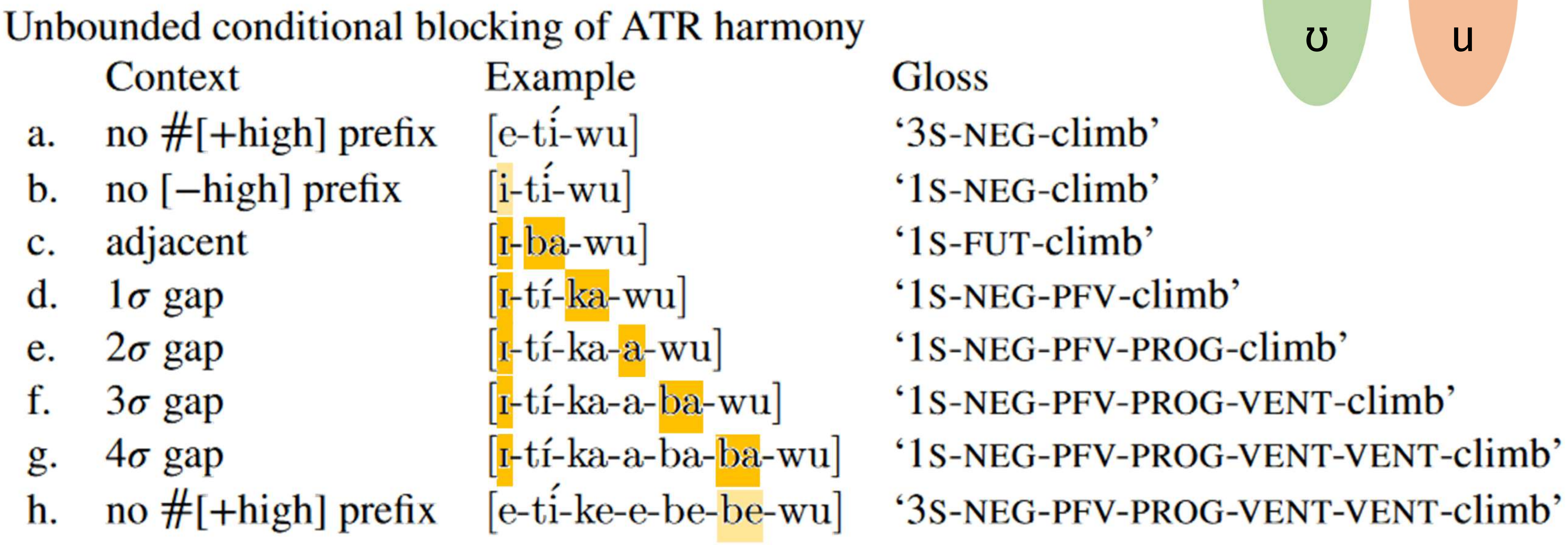
- Type B
  - Blockers **do** operate **(½ of a blocker)**

Tutrugbu harmony





Unbounded conditional blocking of ATR harmony

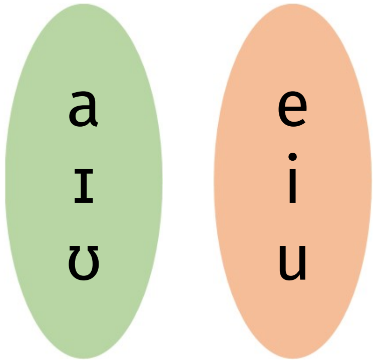
	Context	Example	Gloss
a.	no #[+high] prefix	[e-tí-wu]	‘3S-NEG-climb’
b.	no [−high] prefix	[i-tí-wu]	‘1S-NEG-climb’
c.	adjacent	[ɪ-ba-wu]	‘1S-FUT-climb’
d.	1σ gap	[ɪ-tí-ka-wu]	‘1S-NEG-PFV-climb’
e.	2σ gap	[ɪ-tí-ka-a-wu]	‘1S-NEG-PFV-PROG-climb’
f.	3σ gap	[ɪ-tí-ka-a-ba-wu]	‘1S-NEG-PFV-PROG-VENT-climb’
g.	4σ gap	[ɪ-tí-ka-a-ba-ba-wu]	‘1S-NEG-PFV-PROG-VENT-VENT-climb’
h.	no #[+high] prefix	[e-tí-ke-e-be-be-wu]	‘3S-NEG-PFV-PROG-VENT-VENT-climb’

(McCollum et al. 2020)

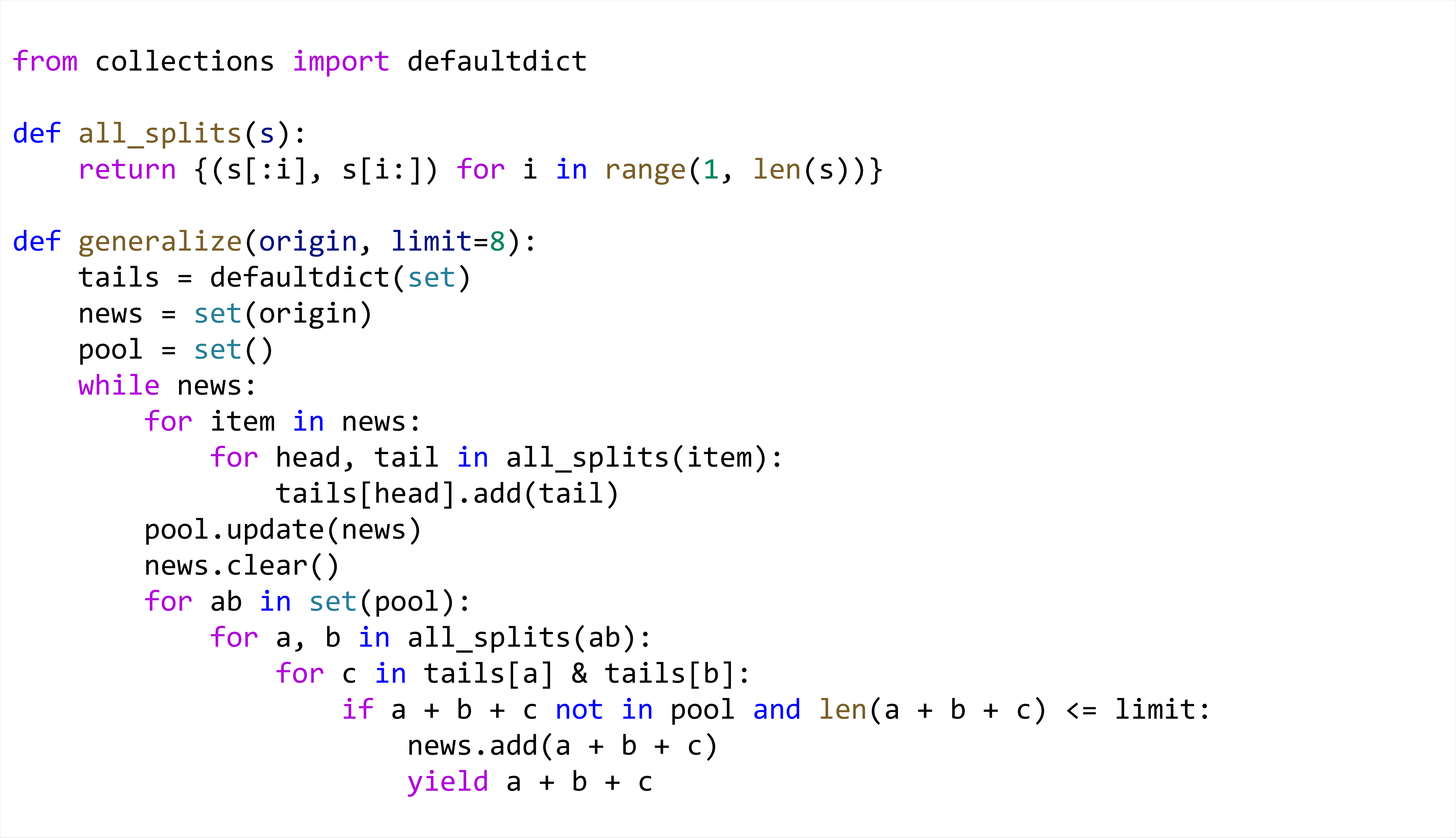
Tutrugbu-like harmony and XYZ-effects

Computational simulation

XY	XZ	YZ	XYZ
mi	mumi	iumi	miumi
imu	imi	mumi	imumi
imemei	imu	memeimu	imemeimu
ɪmai	ɪmamu	imu	ɪmaimu
ɪmai	ɪmamemu	imemu	ɪmaimemu
ɪmai	ɪmame	ime	ɪmaime
ɪmama	ɪmama	mama	ɪmamama
ma	mamʊ	aamʊ	maamʊ
mɪma	mu	ɪmau	mɪmau
mɪma	mi	ɪmai	mɪmai
mɪma	ma	ɪmaa	mɪmaa
mɪma	mɪma	mama	mɪmama
mɪma	mɪmʊ	mamʊ	mɪmamʊ
imemu	imemi	mumi	imemumi



[mɪmau]



```python
from collections import defaultdict

def all_splits(s):
    return {(s[:i], s[i:]) for i in range(1, len(s))}

def generalize(origin, limit=8):
    tails = defaultdict(set)
    news = set(origin)
    pool = set()
    while news:
        for item in news:
            for head, tail in all_splits(item):
                tails[head].add(tail)
        pool.update(news)
        news.clear()
        for ab in set(pool):
            for a, b in all_splits(ab):
                for c in tails[a] & tails[b]:
                    if a + b + c not in pool and len(a + b + c) <= limit:
                        news.add(a + b + c)
                        yield a + b + c
```

Digression: X = Y = Z

Computational simulation

XY	XZ	YZ	XYZ
aa	aa	aa	aaa
aa	aaa	aaa	aaaa
aaa	aaa	aa	aaaa
aaa	aa	aaa	aaaa
aaaa	aa	aaaa	aaaaa
aaaa	aaaa	aa	aaaaa
aaaa	aaa	aaa	aaaaa
aaaa	aaaa	aaaa	aaaaaa
aa	aaaa	aaaa	aaaaa
aaa	aaaa	aaa	aaaaa
aaa	aaa	aaaa	aaaaa
aaaaaa	aaaaaa	aa	aaaaaaa
aaaaaa	aaaa	aaaa	aaaaaaa
aaaaaa	aaaaa	aaaaa	aaaaaaaa

Digression: X = Y = Z

Computational simulation

XY	XZ	YZ	XYZ
aa	aa	aa	aaa
aa	aaa	aaa	aaaa
aaa	aaa	aa	aaaa
aaa	aa	aaa	aaaa
aaaa	aa	aaaa	aaaaa
aaaa	aaaa	aa	aaaaa
aaaa	aaa	aaa	aaaaa
aaaa	aaaa	aaaa	aaaaaa
aa	aaaa	aaaa	aaaaa
aaa	aaaa	aaa	aaaaa
aaa	aaa	aaaa	aaaaa
aaaaaa	aaaaaa	aa	aaaaaaa
aaaaaa	aaaa	aaaa	aaaaaaa
aaaaaa	aaaaa	aaaaa	aaaaaaaa

Digression: X = Y = Z

Computational simulation

XY	XZ	YZ	XYZ
aa	aa	aa	aaa
aa	aaa	aaa	aaaa
aaa	aaa	aa	aaaa
aaa	aa	aaa	aaaa
aaaa	aa	aaaa	aaaaa
aaaa	aaaa	aa	aaaaa
aaaa	aaa	aaa	aaaaa
aaaa	aaaa	aaaa	aaaaaa
aa	aaaa	aaaa	aaaaa
aaa	aaaa	aaa	aaaaa
aaa	aaa	aaaa	aaaaa
aaaaaa	aaaaaa	aa	aaaaaaa
aaaaaa	aaaa	aaaa	aaaaaaa
aaaaaa	aaaaa	aaaaa	aaaaaaaa

Digression: X = Y = Z

Computational simulation

XY	XZ	YZ	XYZ
aa	aa	aa	aaa
aa	aaa	aaa	aaaa
aaa	aaa	aa	aaaa
aaa	aa	aaa	aaaa
aaaa	aa	aaaa	aaaaa
aaaa	aaaa	aa	aaaaa
aaaa	aaa	aaa	aaaaa
aaaa	aaaa	aaaa	aaaaaa
aa	aaaa	aaaa	aaaaa
aaa	aaaa	aaa	aaaaa
aaa	aaa	aaaa	aaaaa
aaaaaa	aaaaaa	aa	aaaaaaa
aaaaaa	aaaa	aaaa	aaaaaaa
aaaaaa	aaaaa	aaaaa	aaaaaaaa

Digression: X = Y = Z

Computational simulation

XY	XZ	YZ	XYZ
aa	aa	aa	aaa
aa	aaa	aaa	aaaa
aaa	aaa	aa	aaaa
aaa	aa	aaa	aaaa
aaaa	aa	aaaa	aaaaa
aaaa	aaaa	aa	aaaaa
aaaa	aaa	aaa	aaaaa
aaaa	aaaa	aaaa	aaaaaa
aa	aaaa	aaaa	aaaaa
aaa	aaaa	aaa	aaaaa
aaa	aaa	aaaa	aaaaa
aaaaaa	aaaaaa	aa	aaaaaaa
aaaaaa	aaaa	aaaa	aaaaaaa
aaaaaa	aaaaa	aaaaa	aaaaaaaa

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Morphology

Inputs:

- farm-s_{PL}
- house-s_{PL}
- farm-house

Output:

- farm-house-s_{PL}

Can one dispense with compounds in illustrating this?

Can one dispense with compounds?

- Only one root:
  - contained in X, **or**
  - contained in Y, **or**
  - contained in Z
- Assume it is contained in X
  - **YZ would have no root!**
- One might say that an XYZ-effect holds in a silent, **unproductive** manner
  - Input tuples of the shape (XY, XZ, YZ) barely exist

A more lenient alternative, perhaps?

Inputs:

- XY…
- X…Z
- …YZ

Output:

- XYZ

?

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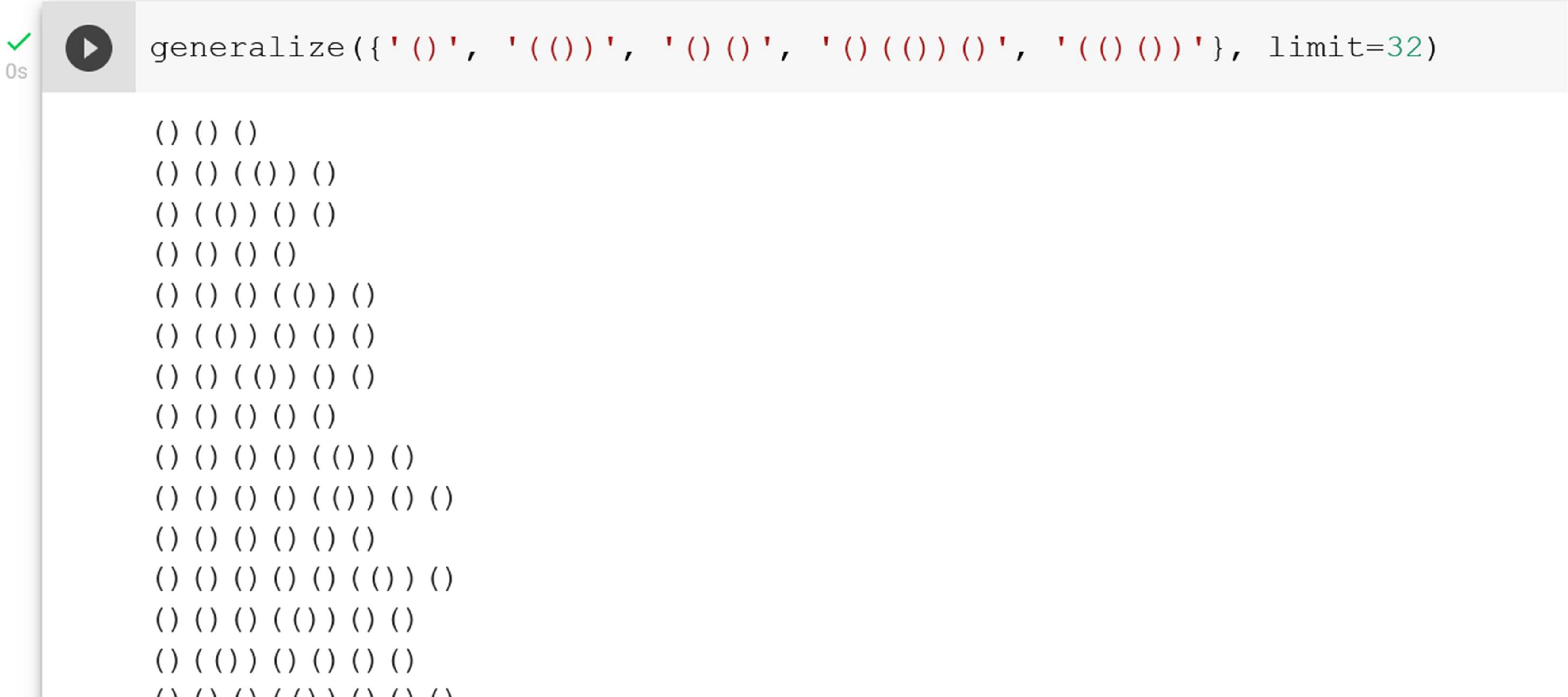
The syntax situation

- An XYZ effect could only be productive in marginal cases:
  - *I think I think* → *I think I think I think*
- The “no root” argument becomes a “no head” argument
- The more lenient version is by far too lenient now

Balanced parentheses



```
generalize({'()', '(())', '()()', '()(())()', '(()())'}, limit=32)
```

```
()()()
()()(())()
()(())()()
()()()()
()()()(())()
()(())()()()
()()(())()()
()()()()()
()()()()(())()
()()()()(())()()
()()()()()()
()()()()()(())()
()()()(())()()
()(())()()()()
()()()(())()()()
```

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Induction procedure

- Essentially the `generalize()` from the code listing some slides ago
- Could compete with substance-free models of phonotactic inference
  - e. g. formal-language-theoretic models
- Major advantage: simplicity
- Major disadvantage: generalizes in an excessively cautious and conservative manner
- Typical optimality-theoretic approaches are not substance-free, and therefore not comparable
- The recombinant, parameter-free approach of XYZ-based induction is conceptually attractive

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Thank you!