Complex simplex numerals

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Two functions

Two functions of numerals

Bultinck (2005), Rothstein (2013, 2017)

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- abstract counting ⇒ reference to a number concept

(1) a. Ten divided by five equals two.
b. Five is a Fibonacci number.

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Bultinck (2005), Rothstein (2013, 2017)

- abstract counting ⇒ reference to a number concept

(1) a. Ten divided by five equals two.
b. Five is a Fibonacci number.

- object counting ⇒ quantification over entities

(2) a. five cats
b. the five girls

The main claim

Question

- what is the relationship between object-counting and abstract-counting numerals?

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Data

- we look at morphological relations between the two types of numerals

Distinguishing the two functions

Abstract number concepts

Rothstein (2013, 2017)

- distinct properties than pluralities of individuals

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(3) a. Five is prime.
b. Five is odd.
c. Five is a Fibonacci number.

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(3) a. Five is prime.
b. Five is odd.
c. Five is a Fibonacci number.

(4) a. #Five things are prime.
b. #Five things are odd.
c. #Five things are a Fibonacci number.

Distinguishing the two functions

Abstract number concepts

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- compatibility with mathematical contexts

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(5) a. Five times two equals ten.
b. Five is smaller than six.
c. Johnny can count up to five.

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(6) a. #Five things times two things equals ten things.
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Distinguishing the two functions

Modification by numeral modifiers

cf. Corbett (1978), Babby (1987), Nouwen (2010)

- only object-counting numerals allow for modification

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b. At least five children got sick.
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(8)
a. #More than five is a Fibonacci number.
b. #At least five times two equals ten.
c. #All five is odd.

Morphological marking patterns

Meaning/form correspondences

cf. Greenberg (1978), Hurford (1998, 2001)

- languages mark the distinction in various ways

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OBJECT	A		
	syncretism		

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Syncretism

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(9) a. five cats
b. Ten divided by five equals two.

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(9) a. five cats
b. Ten divided by five equals two.

(10) a. pět koček
five cats
'five cats'
b. Dva plus pět je sedm.
two plus five is seven
'Two plus five is seven.'

Czech

Stacking

Stacking: object counting > abstract counting

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(11) a. *go-no ringo
five-GEN apple

b. go-ko-no ringo
five-CL-GEN apple
'five apples' Japanese

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(12) a. juu waru go-wa ni-da.
ten divide.by five-TOP two-COP
'Ten divided by five is two.' Japanese

b. #juu-ko waru go-ko-wa ni-ko-da.
ten-CL divide.by five-CL-TOP two-CL-COP

Suppletion

Suppletivism: object counting $\neq$ abstract counting

cf. Greenberg (1978), A. Borg (1974), A. J. Borg (1987), Hurford (1998, 2001)

- morphologically independent forms for 2 in Maltese

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cf. Greenberg (1978), A. Borg (1974), A. J. Borg (1987), Hurford (1998, 2001)

- morphologically independent forms for 2 in Maltese

(13) a. *tnejn nisa
two women

b. żewġ nisa
two women
'two women'

Maltese

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'two women' Maltese

(14) a. Tnejn u tnejn jagħmlu erbgħa.
two and two they-make four
'Two and two make four.' Maltese

b. *Żewġ u żewġ jagħmlu erbgħa.
two and two they-make four

Syncretism

Numerals in Shuhi (Qiangic)

Qi & He (2019)

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(15)

a. rɔʔ^{35} dʑi^{33}-ko^{35}
horse one-CL
'one horse'

b. nɯ^{55}gu^{31} dʑi^{33}-ly^{55}
cloth one-CL
'one cloth'

c. lɑ^{33}re^{55} dʑi^{33}-ʈshu^{55}
towel one-CL
'one towel'

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Shuhi (Qiangic)

(16) dʑi^{33}-ko^{35}-re^{33} dʑi^{33}-ko^{35}-ɦo∼^{33} me^{33}-ba^{33}-le^{55} ɳe^{33}-ko^{35}
one-CL-ABL one-CL-LOC DIR-add-AUX two-CL
le^{33}-ʑi?^{33}-dʑo∼^{33}.
DIR-become-DUR
'One plus one is two.'

Shuhi (Qiangic)

Stacking

Numerals 1–5 in Vera’a (Vanuatu)

Schnell (2011)

Stacking

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NUMBER	CARDINAL	MULTIPLICATIVE
1	vō-wal	vag-wal
2	vō-ruō	vag-ruō
3	vō-'ōl	vag-'ōl
4	vō-ve'	vag-ve'

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(17) vēvē-gi ne lukun ēn naw, din ēn vō-’ōl...
mother-3SG TAM count ART wave reach ART NBR-three
‘Then his mother counted the waves reaching (the number) three...’

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Vera'a (Vanuatu)

(18) ēn woqe'enge ne vō-ru
ART tree LIG NBR-two
'two trees'
Vera'a (Vanuatu)

Suppletion

Abkhaz (Northwest Caucasian)

Hewitt (1979, 2010), Chirikba (2003)

- suffix -ba ⇒ abstract counting
- suffix -j°ə́(k’) ⇒ numerals counting humans
- twist: -ba also on numerals used to count non-human objects

NUMBER	ABSTRACT	OBJECT
4	pš’-ba	pš’-j°ə́(k’)
5	x°-ba	x°-j°ə́(k’)
6	f-ba	f-j°ə́(k’)
7	bəž’-ba	bəž’-j°ə́(k’)
8	aa-ba	aa-j°ə́(k’)

Summary

	TYPE	LANGUAGE	NUMBER	ABSTRACT	OBJECT
SIMPLEX	SYNCRETISM	English	5	five	five
	STACKING	Japanese	5	go	go-ko
	SUPPLETION	Maltese	2	tnejn	żewġ

Summary

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COMPLEX	SYNCRETISM	Shuhi	5	ŋ̥e^{33}-ko^{35}	ŋ̥e^{33}-ko^{35}
	STACKING	Vera'a	2	vō-ruō	ne-vō-ruō
	SUPPLETION	Abkhaz	5	x°-ba	x°-j°ə́(k')

Universal semantic features

Key intuition concerning numerals

- numerals are at their core scalar entities

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- research on spatial/directional numeral modifiers

(19) a. above five
b. between five and eight

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(19) a. above five
b. between five and eight

- interval-based semantics of degree

(20) a. Anne is taller than everybody else is.
b. Anne has more cats than everybody else.

Universal semantic features

Standard approach to classifiers

e.g., Borer (2005), Chierchia (1998, 2010), Rothstein (2010), Li (2011), Scontras (2013)

- mass-like semantics of nouns in classifier languages
- classifiers compensate semantic deficits of nouns

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Alternative view

Krifka (1995), Bale & Coon (2014), Sudo (2016)

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Counting via measure functions

Krifka (1989)

- natural unit/object unit operation
- #(P) maps a plurality to a number of individuals

Universal semantic features

Three semantic primitives

- closed interval $\Rightarrow$ set of numbers

(21) a. $[\![\textsc{Scale}_m]\!]_{\langle n,t\rangle} = \lambda n_n[0 \leq n \leq m]$
b. $[\![\textsc{Scale}_5]\!] = [0, 5]$

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- maximization operator $\Rightarrow$ name of a number concept

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- classifier semantics ⇒ shift to a predicate modifier

(23) a. $[\![\textsc{Cl}]\!]_{\langle n,\langle\langle e,t\rangle,\langle e,t\rangle\rangle\rangle} = \lambda n_n \lambda P_{\langle e,t\rangle} \lambda x_e[{}^*P(x) \wedge \#(P)(x) = n]$
b. $[\![\textsc{Cl}]\!]([\![\textsc{Num}]\!]([\![\textsc{Scale}_5]\!])) = \lambda P_{\langle e,t\rangle} \lambda x_e[{}^*P(x) \wedge \#(P)(x) = 5]$

Universal semantic features

Structures

- abstract-counting numerals

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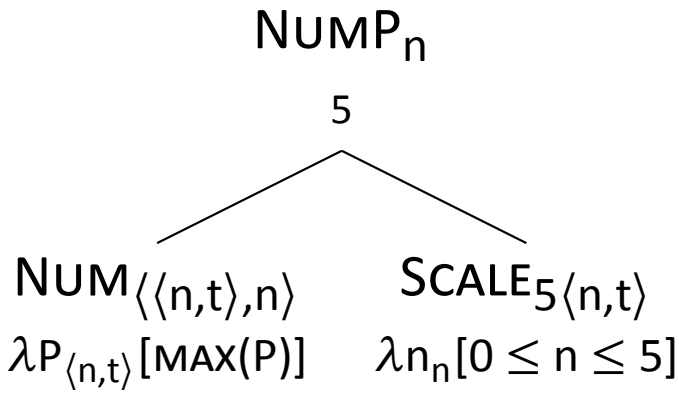
(24)



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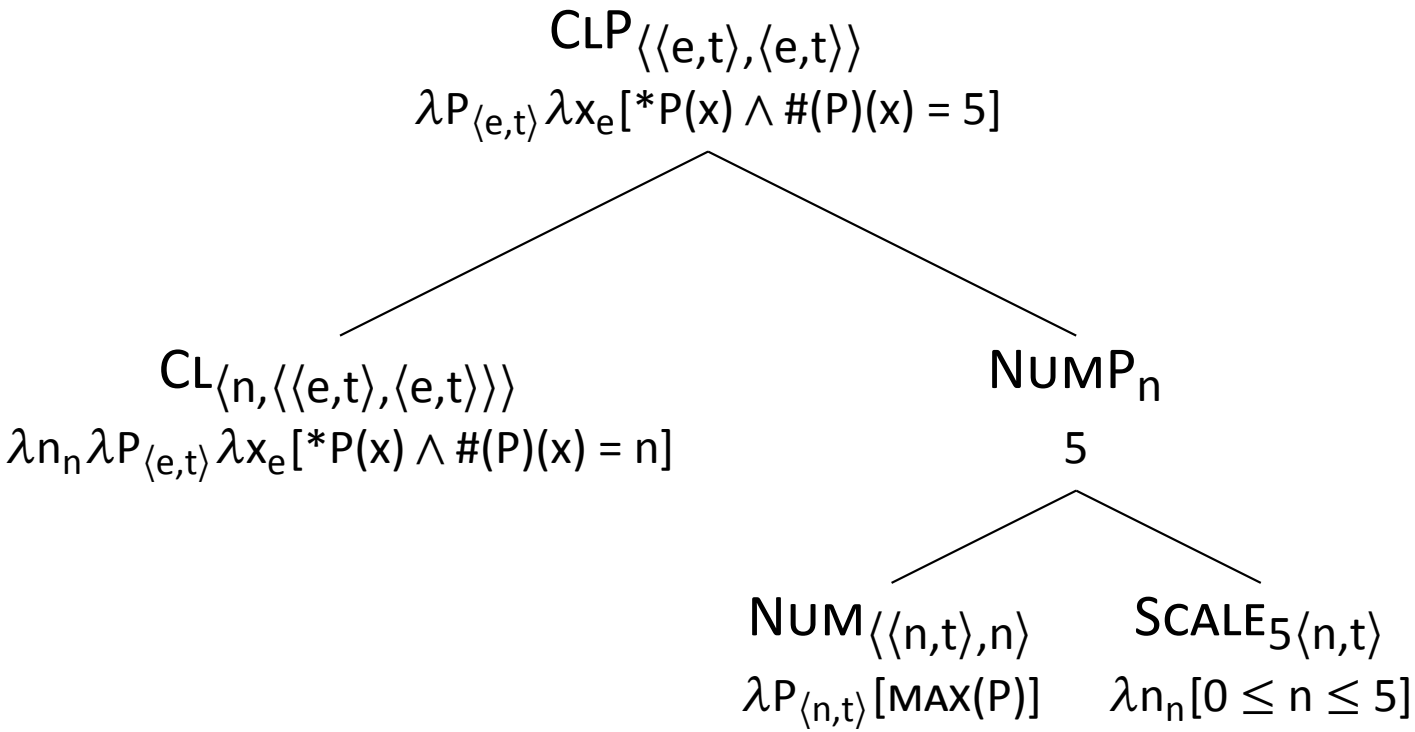

Nanosyntax

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- maps structures to their pronunciation using lexical entries
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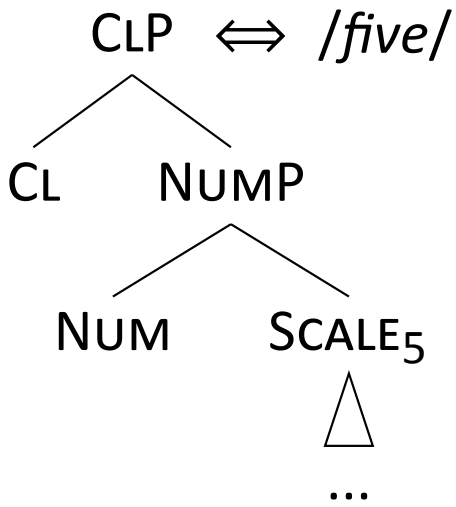
- spellout driven movement
- deriving different lexicalizations ⇒ account for the typology

Simplex numerals: Syncretism

ABSTRACT			OBJECT		
SCALE	NUM		SCALE	NUM	CL
five		ENG 5	*five*		

Simplex numerals: Syncretism

(26)



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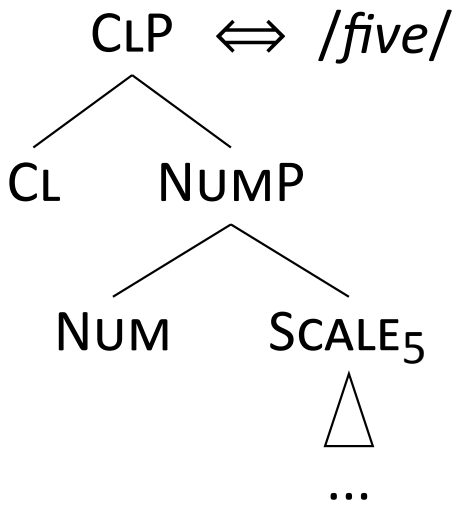

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A lexically stored tree L matches a syntactic node S iff L contains the syntactic tree dominated by S as a subtree.

Simplex numerals: Syncretism

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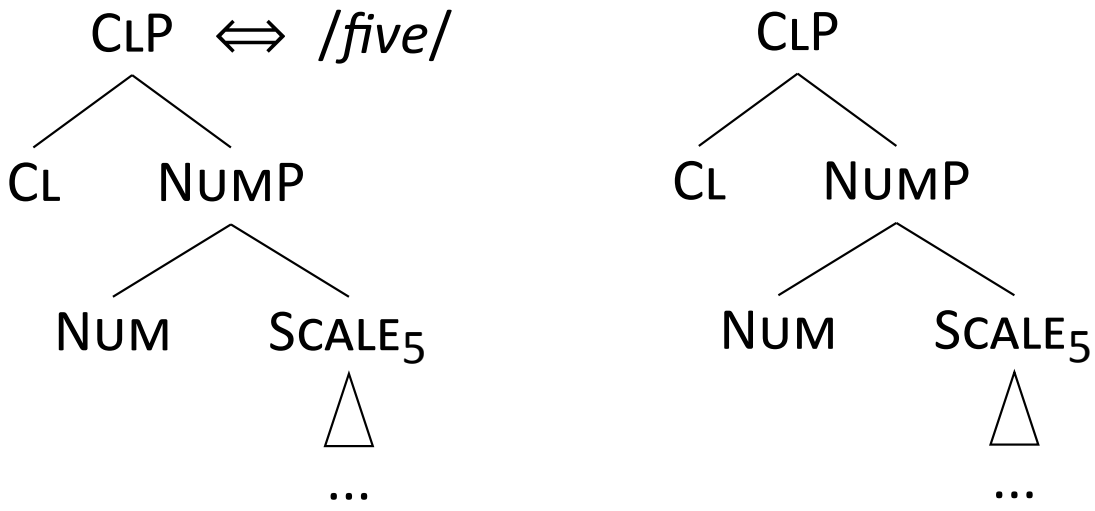

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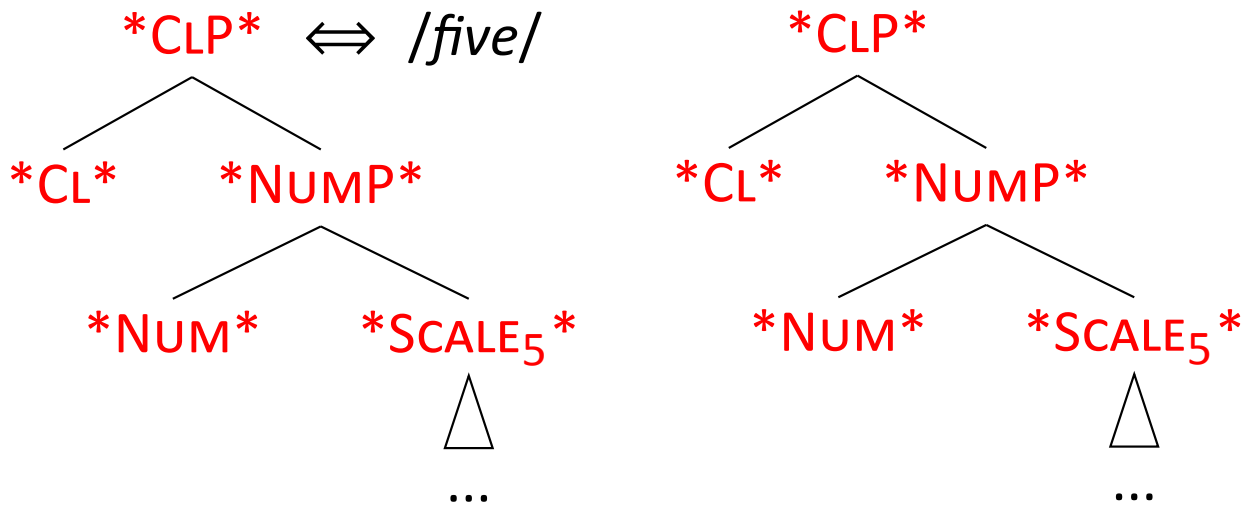

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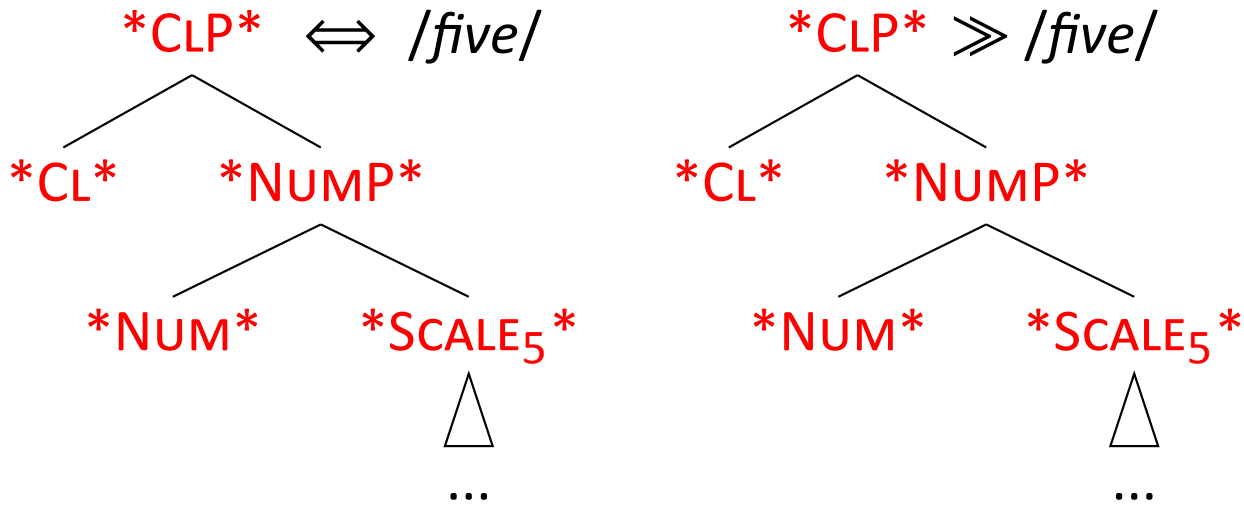

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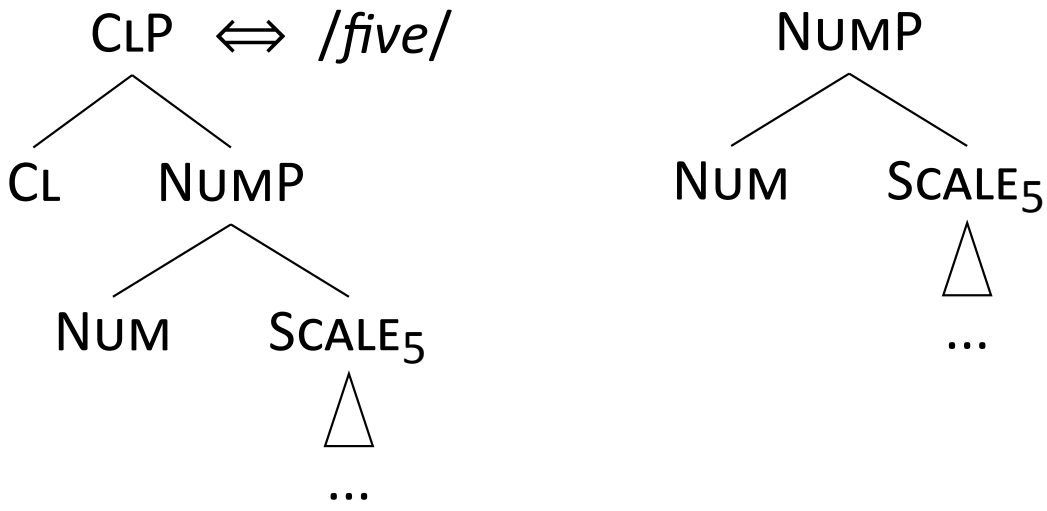

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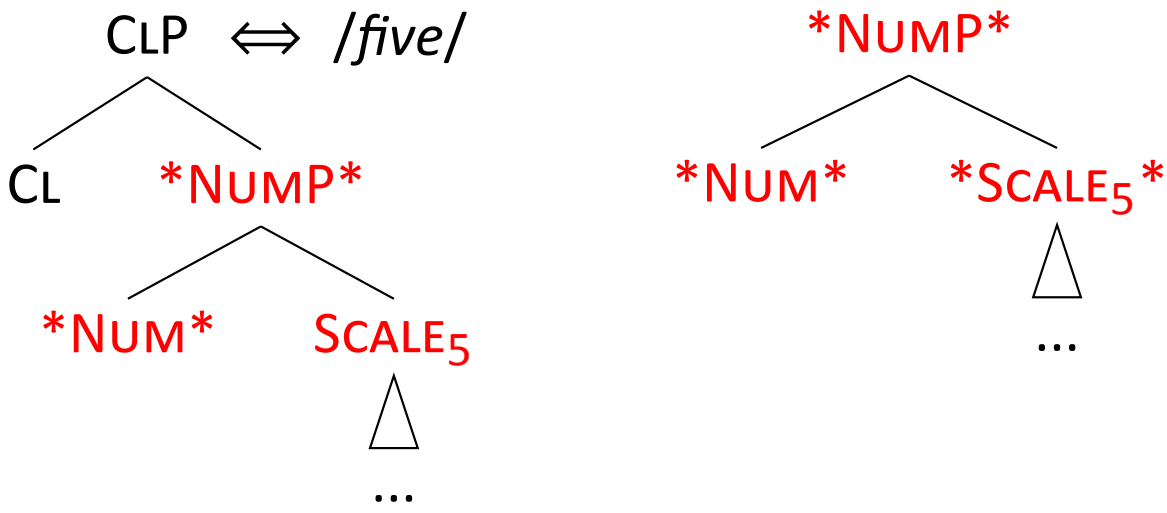

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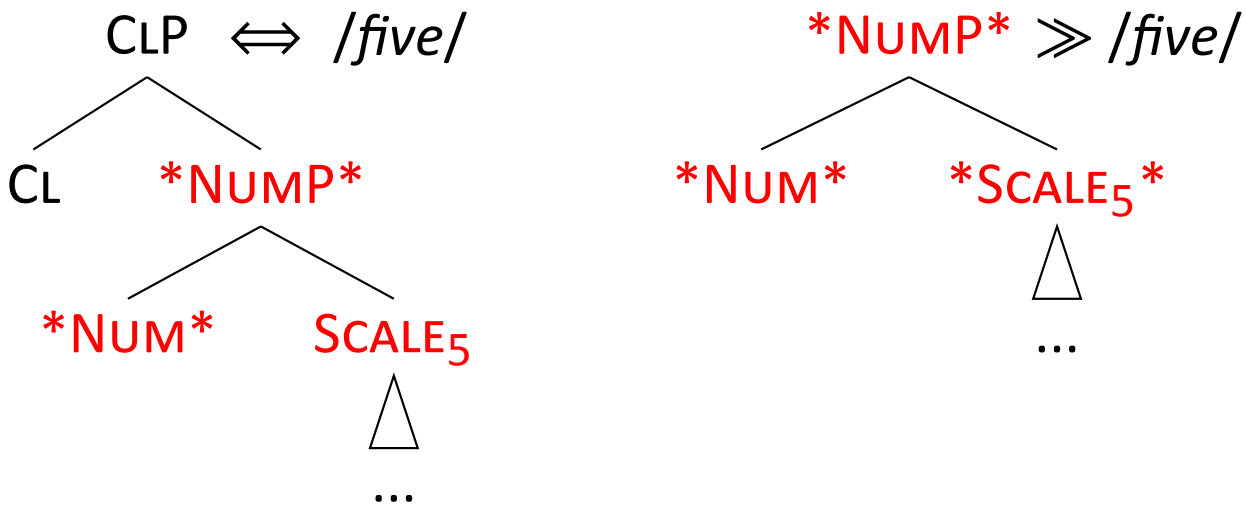

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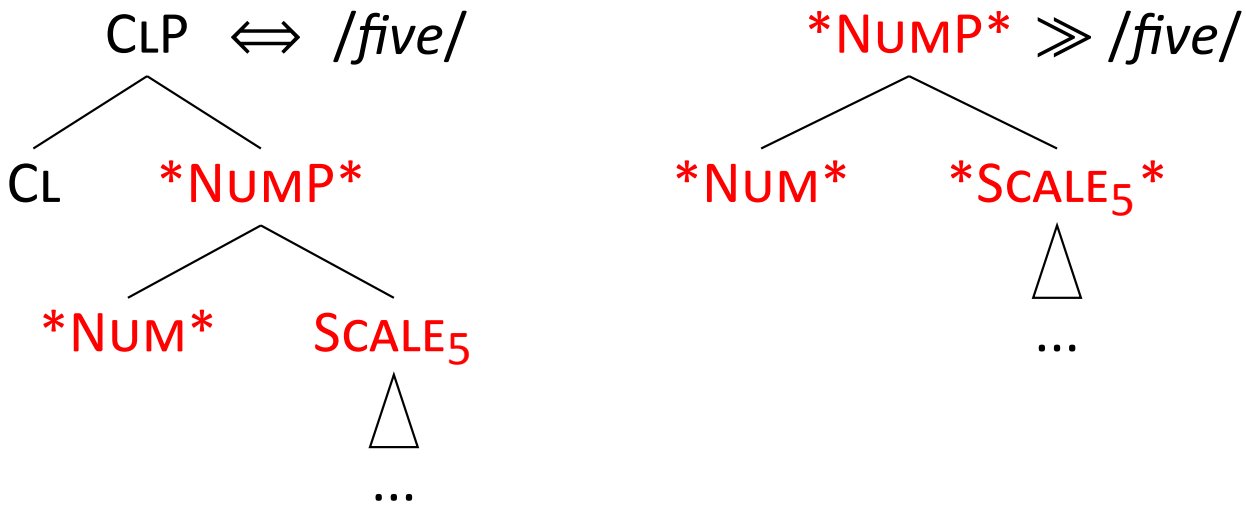

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Simplex numerals: Suppletion

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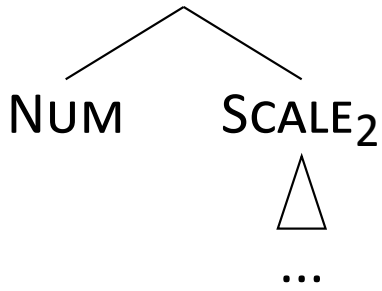
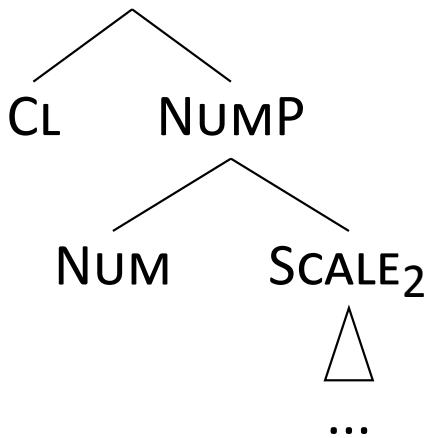
ABSTRACT			OBJECT		
SCALE	NUM		SCALE	NUM	CL
five		ENG 5	*five*		
tnejn		MLT 2	*żewġ*		

Simplex numerals: Suppletion

(29) NUMP ⟺ */tnejn/*

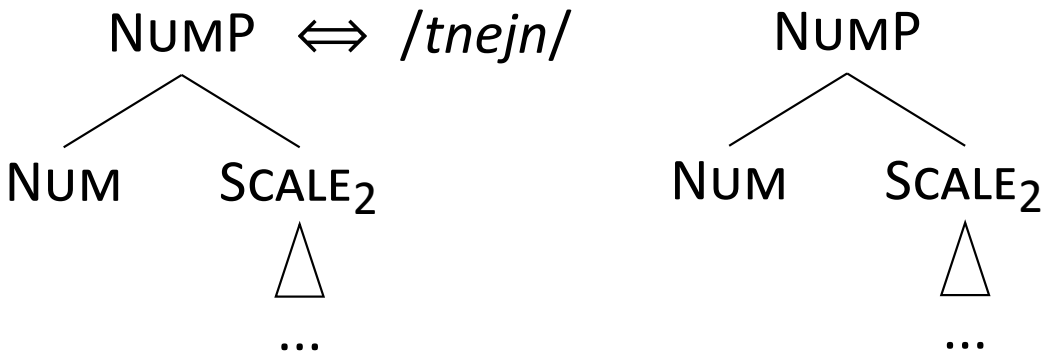


(30) CLP ⟺ */żewġ/*

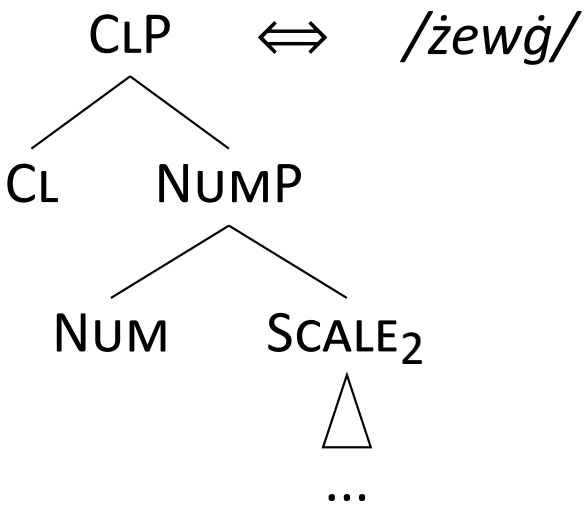


Simplex numerals: Suppletion

(29)

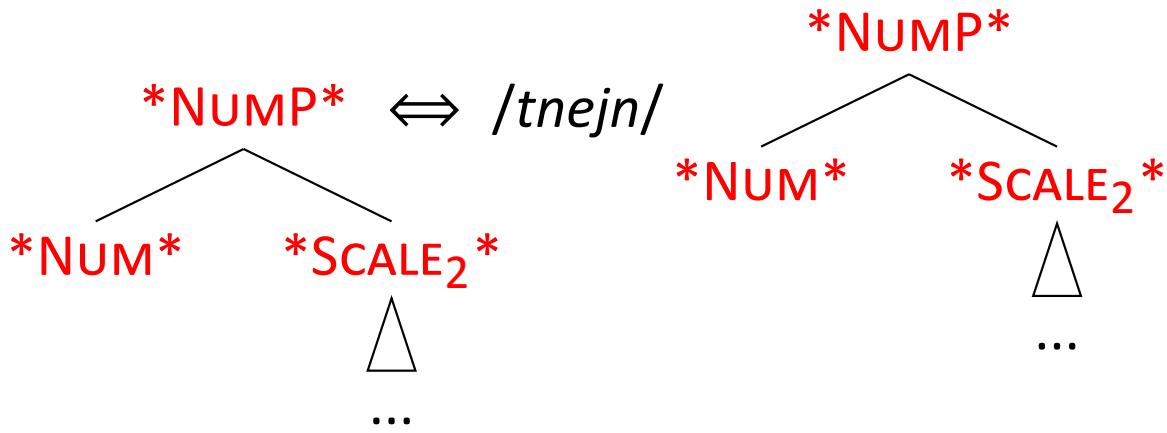


(30)

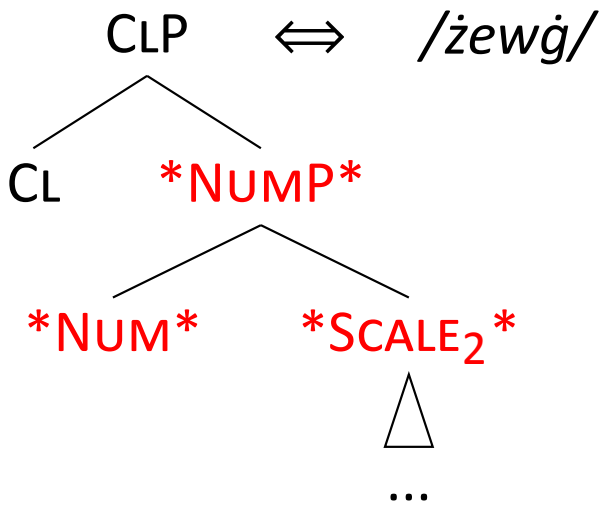


Simplex numerals: Suppletion

(29)



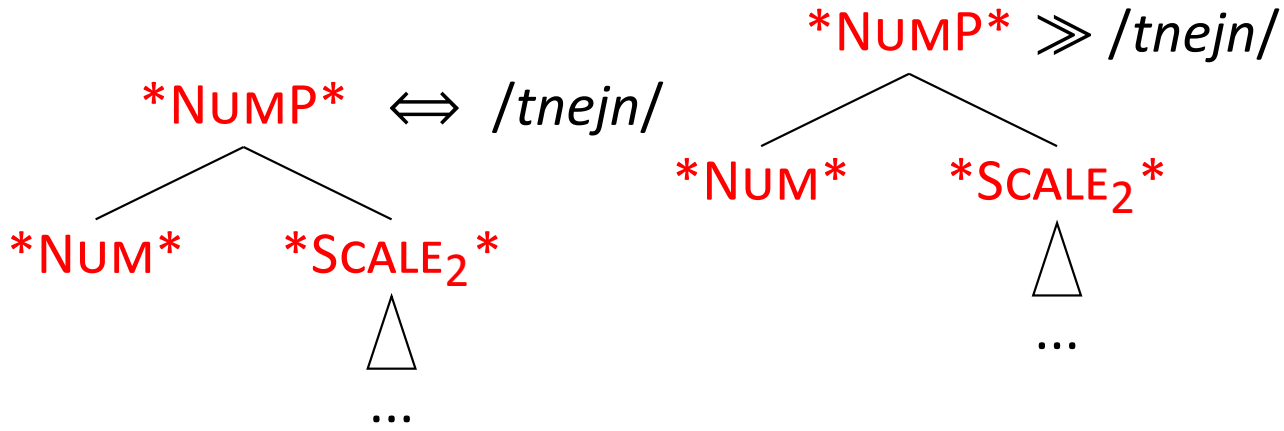
(30)



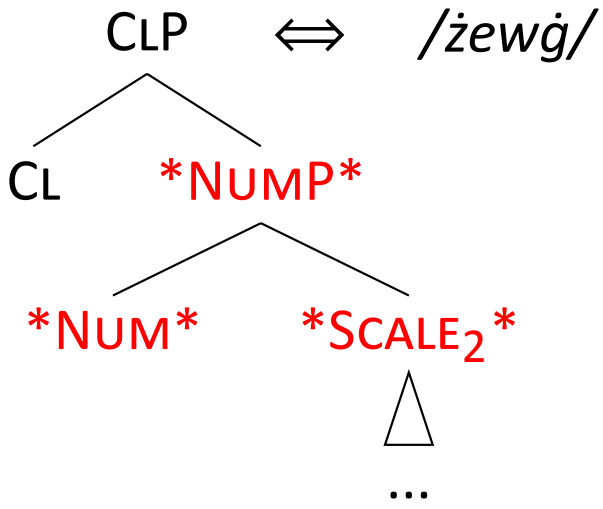
(31) THE ELSEWHERE CONDITION (Kiparsky 1973):
When multiple items match, chose the more specific one (it has fewer superfluous features).

Simplex numerals: Suppletion

(29)



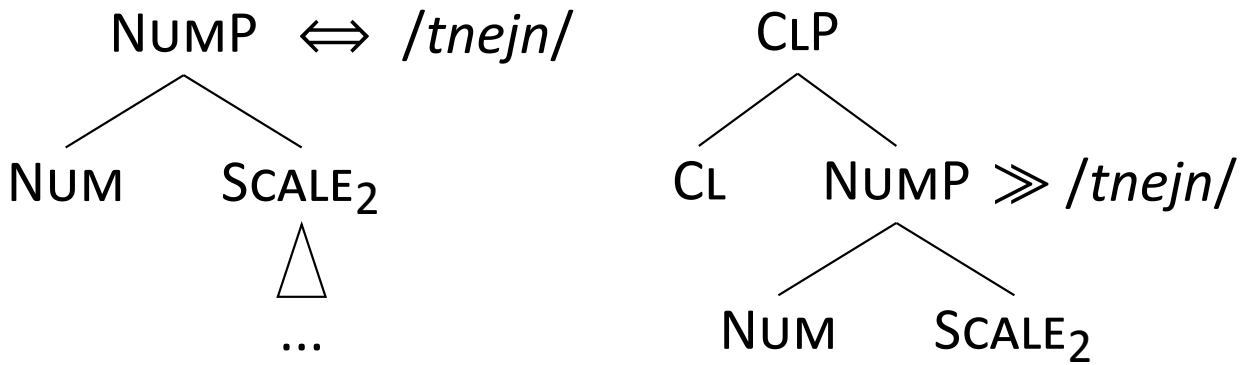
(30)



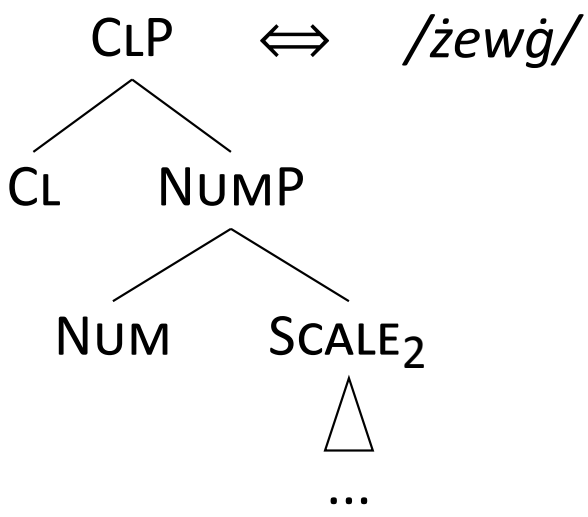
(31) THE ELSEWHERE CONDITION (Kiparsky 1973):
When multiple items match, chose the more specific one (it has fewer superfluous features).

Simplex numerals: Suppletion

(29)



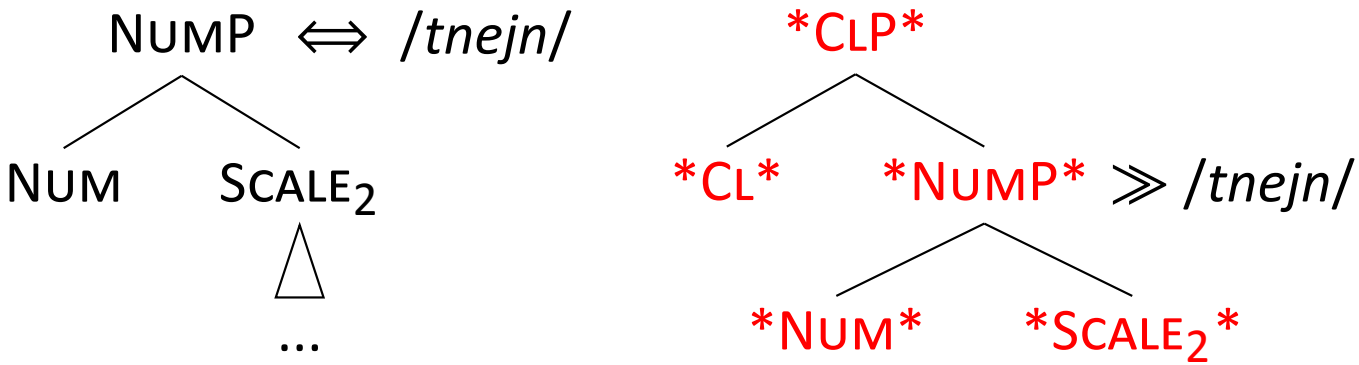
(30)



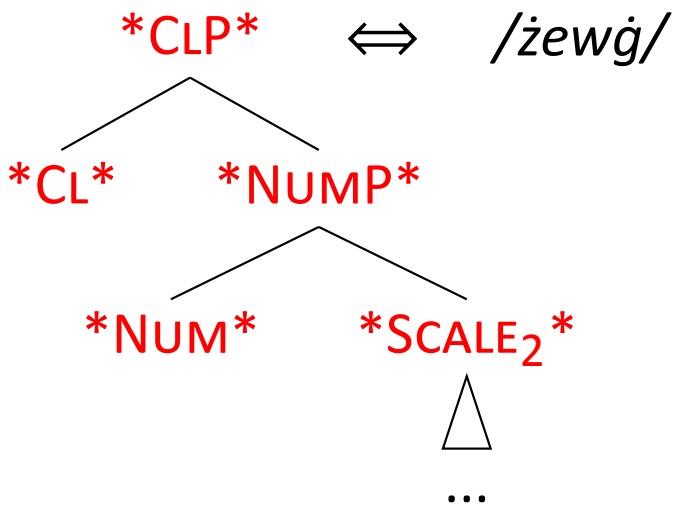
(31) THE ELSEWHERE CONDITION (Kiparsky 1973):
When multiple items match, chose the more specific one (it has fewer superfluous features).

Simplex numerals: Suppletion

(29)



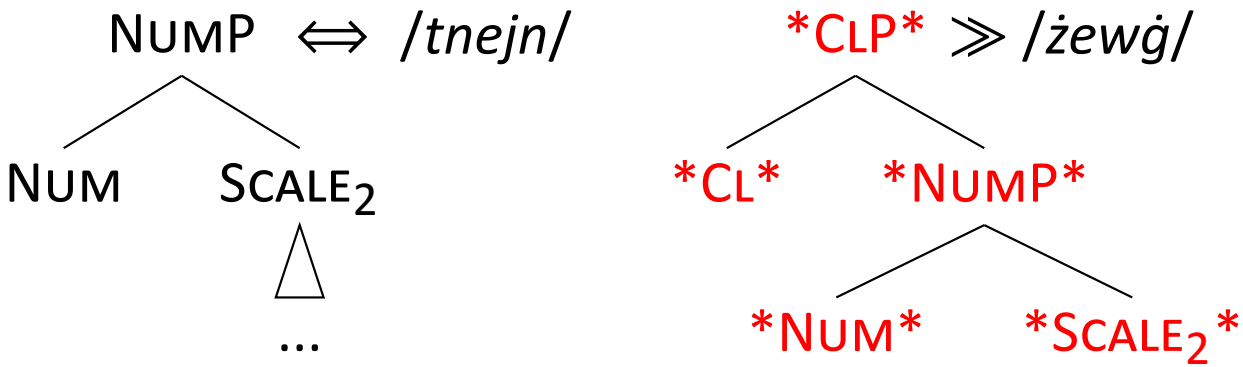
(30)



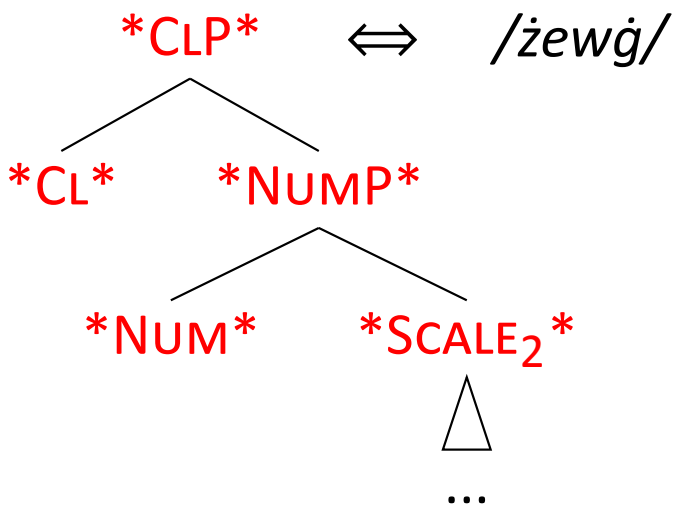
(31) THE ELSEWHERE CONDITION (Kiparsky 1973):
When multiple items match, chose the more specific one (it has fewer superfluous features).

Simplex numerals: Suppletion

(29)



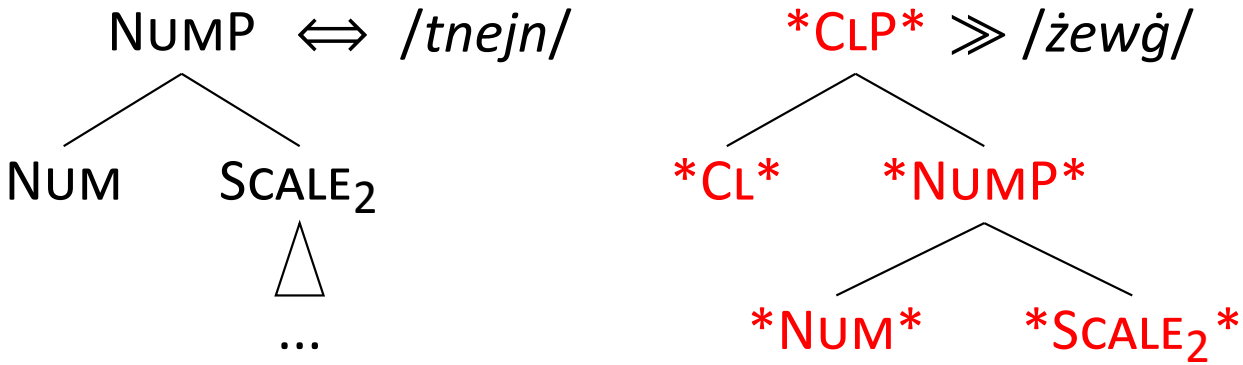
(30)



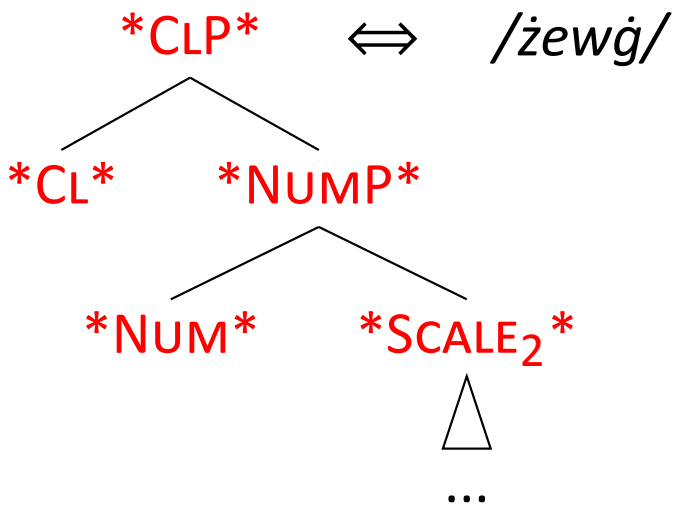
(31) THE ELSEWHERE CONDITION (Kiparsky 1973):
When multiple items match, chose the more specific one (it has fewer superfluous features).

Simplex numerals: Suppletion

(29)



(30)



(31)

ABSTRACT			OBJECT		
SCALE	NUM		SCALE	NUM	CL
five		ENG 5	*five*		
tnejn		MLT 2	*żewġ*		

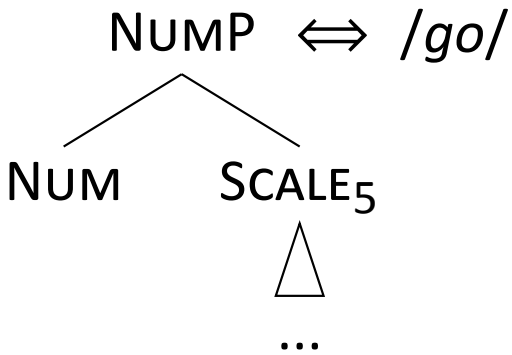
Simplex numerals: Stacking

(32)

ABSTRACT			OBJECT		
SCALE	NUM		SCALE	NUM	CL
five		ENG 5	*five*		
tnejn		MLT 2	*żewġ*		
go		JPN 5	*go*		*ko*

Simplex numerals: Stacking

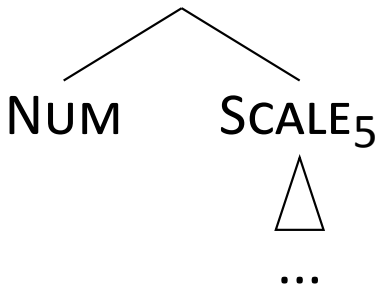
(33)

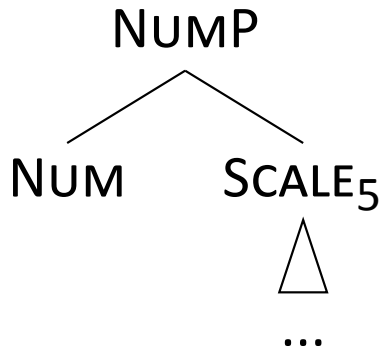


(34)

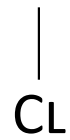
Simplex numerals: Stacking

(33) NUMP ⟺ */go/*





(34) CLP ⟺ */ko/*



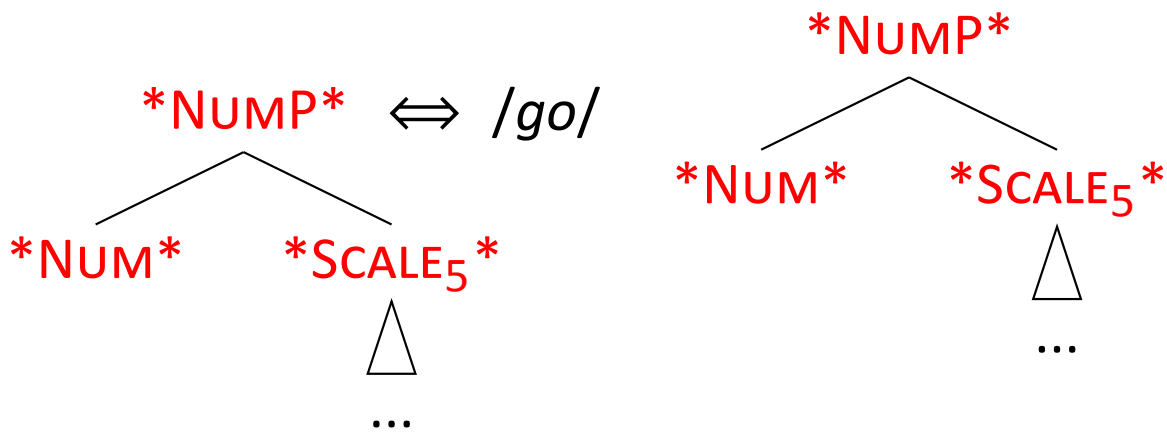
(35) Merge F and

a. Spell out FP

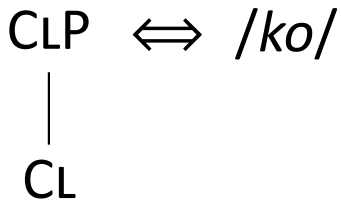
b. If (a) fails, move the complement of F, and retry (a)

Simplex numerals: Stacking

(33)



(34)



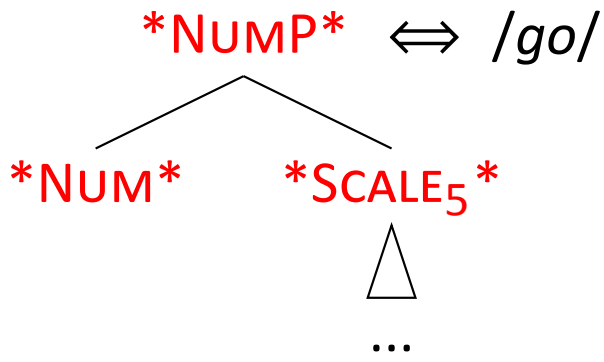
(35) Merge F and

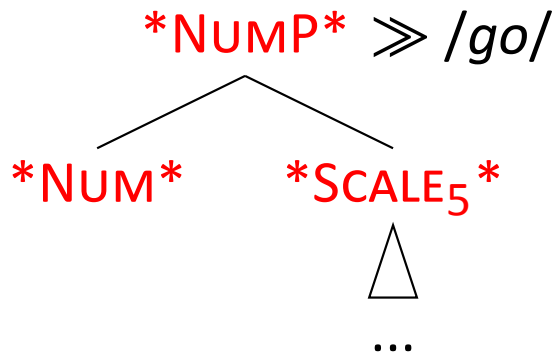
a. Spell out FP

b. If (a) fails, move the complement of F, and retry (a)

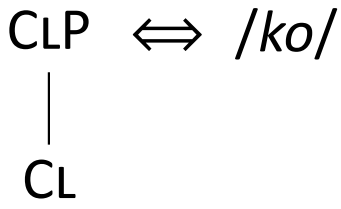
Simplex numerals: Stacking

(33)





(34)



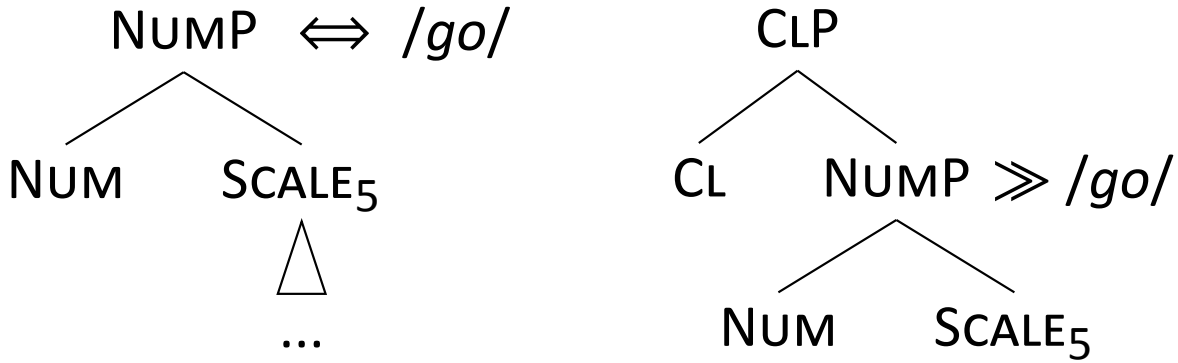
(35) Merge F and

a. Spell out FP

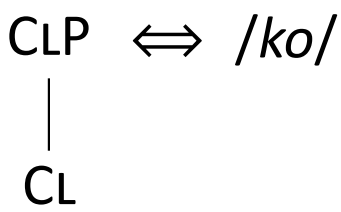
b. If (a) fails, move the complement of F, and retry (a)

Simplex numerals: Stacking

(33)



(34)



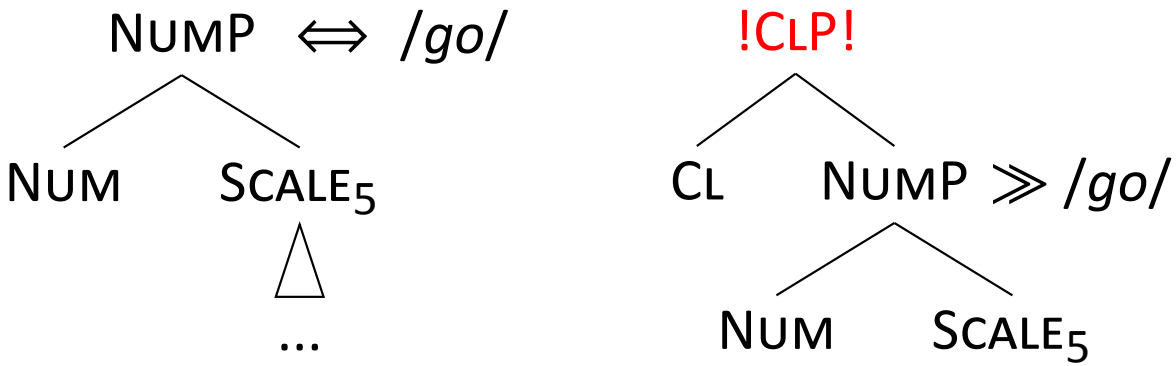
(35) Merge F and

a. Spell out FP

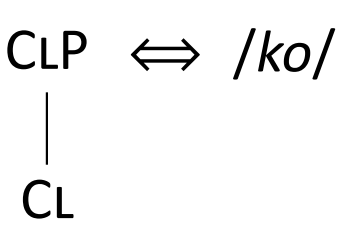
b. If (a) fails, move the complement of F, and retry (a)

Simplex numerals: Stacking

(33)



(34)



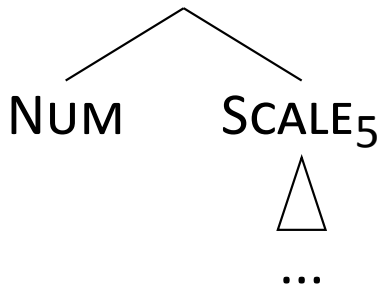
(35) Merge F and

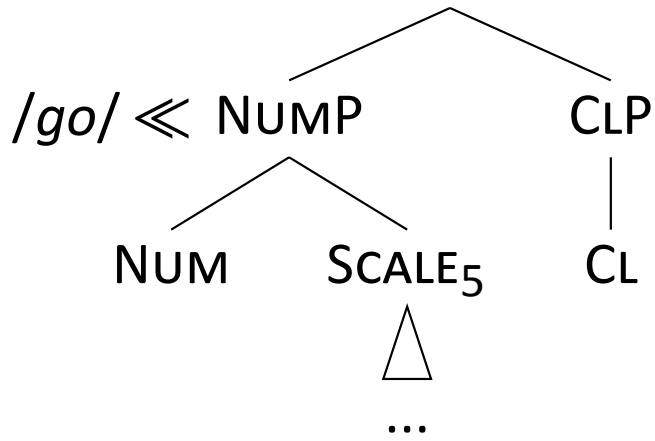
a. Spell out FP

b. If (a) fails, move the complement of F, and retry (a)

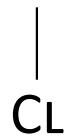
Simplex numerals: Stacking

(33) NUMP $\Leftrightarrow$ */go/*





(34) CLP $\Leftrightarrow$ */ko/*



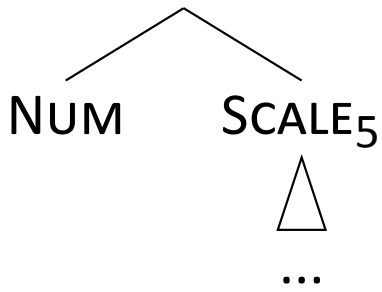
(35) Merge F and

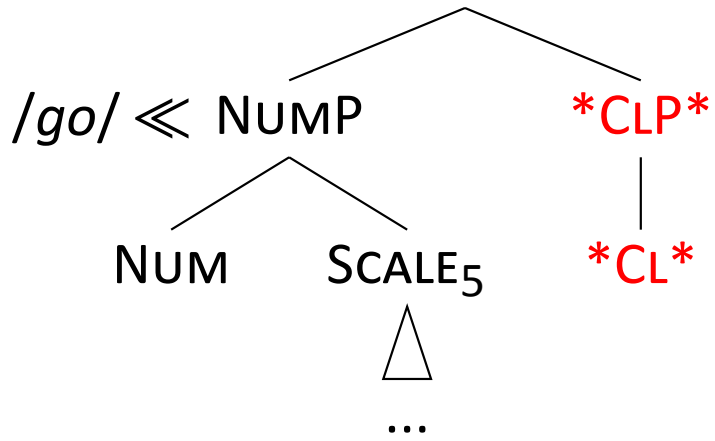
a. Spell out FP

b. If (a) fails, move the complement of F, and retry (a)

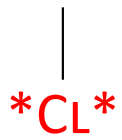
Simplex numerals: Stacking

(33) NUMP ⟺ */go/*





(34) *CLP* ⟺ */ko/*



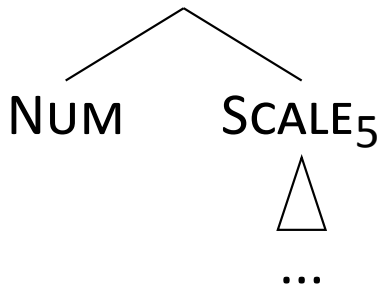
(35) Merge F and

a. Spell out FP

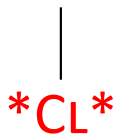
b. If (a) fails, move the complement of F, and retry (a)

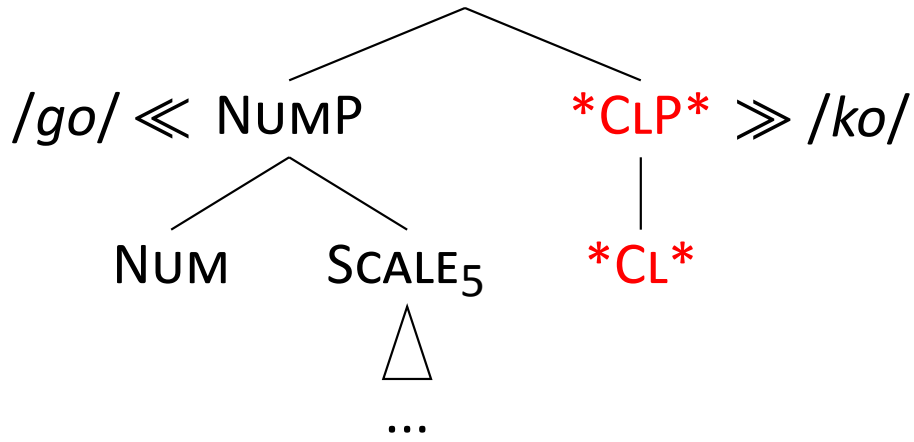
Simplex numerals: Stacking

(33) NUMP ⟺ */go/*



(34) **CLP** ⟺ */ko/*





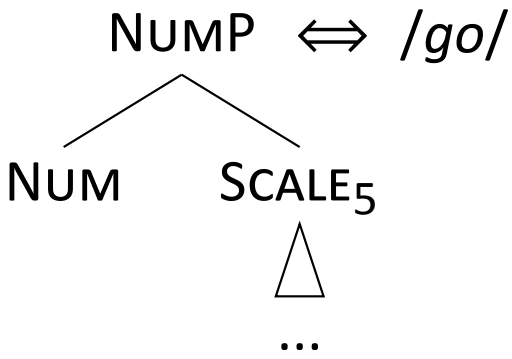
(35) Merge F and

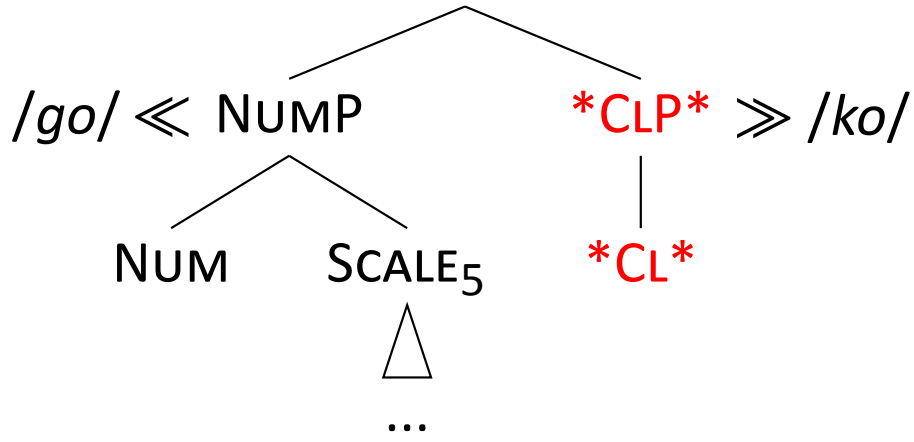
a. Spell out FP

b. If (a) fails, move the complement of F, and retry (a)

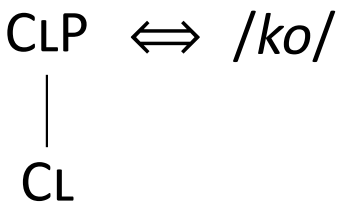
Simplex numerals: Stacking

(33)





(34)



(35)

ABSTRACT		OBJECT	
SCALE NUM		SCALE NUM	CL
five	ENG 5	*five*	
tnejn	MLT 2	*żewġ*	
go	JPN 5	*go*	*ko*

Complex numerals: Syncretism

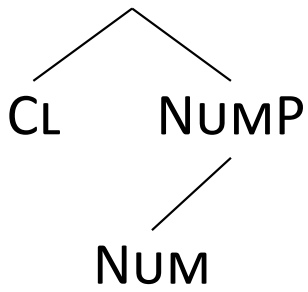
ABSTRACT			OBJECT		
SCALE	NUM		SCALE	NUM	CL
five		ENG 5	*five*		
tnejn		MLT 2	*żewġ*		
go		JPN 5	*go*		*ko*
ŋe^{33}	*ko*^{35}	SHU 1	*ŋe*^{33}	ko^{35}	

Complex numerals: Syncretism

(36) SCALE$_1$ $\Leftrightarrow$ /ŋe^{33}/

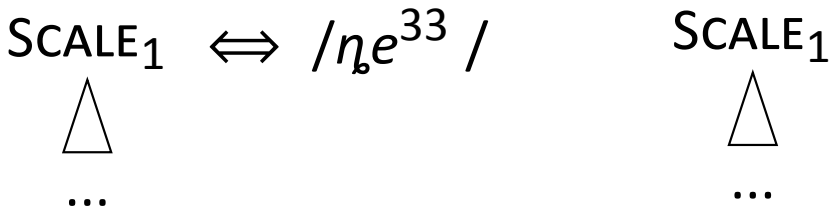
...

(37) CLP $\Leftrightarrow$ /ko^{35}/

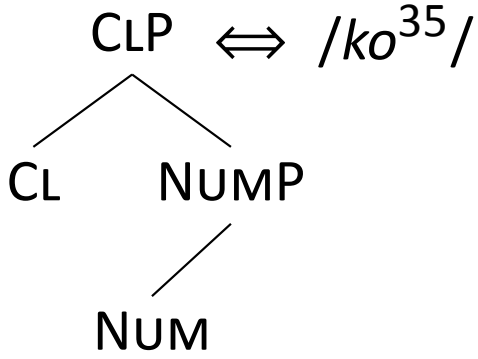


Complex numerals: Syncretism

(36)



(37)



(38)

a. Spell out FP

b. If (a) fails, attempt movement of the spec of the complement of F, and retry (a)

c. If (b) fails, move the complement of F, and retry (a)

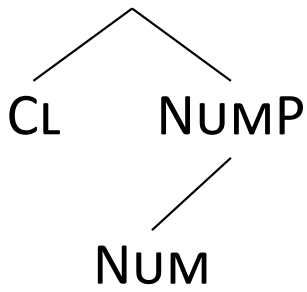
Complex numerals: Syncretism

(36) *SCALE$_1$* $\Leftrightarrow$ /ŋe^{33}/ *SCALE$_1$*

...

...

(37) CLP $\Leftrightarrow$ /ko^{35}/

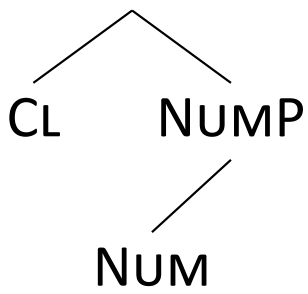


(38)
a. Spell out FP
b. If (a) fails, attempt movement of the spec of the complement of F, and retry (a)
c. If (b) fails, move the complement of F, and retry (a)

Complex numerals: Syncretism

(36) *SCALE$_1$* $\Leftrightarrow$ /ŋe^{33} / *SCALE$_1$* $\gg$ /ŋe^{33}/

(37) CLP $\Leftrightarrow$ /ko^{35}/



(38)
a. Spell out FP
b. If (a) fails, attempt movement of the spec of the complement of F, and retry (a)
c. If (b) fails, move the complement of F, and retry (a)

Complex numerals: Syncretism

(36) SCALE$_1$ $\Leftrightarrow$ /ŋe^{33}/

...

NUMP

NUM SCALE$_1$ $\gg$ /ŋe^{33}/

...

(37) CLP $\Leftrightarrow$ /ko^{35}/

CL NUMP

NUM

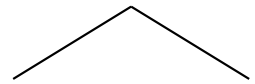
(38)
a. Spell out FP
b. If (a) fails, attempt movement of the spec of the complement of F, and retry (a)
c. If (b) fails, move the complement of F, and retry (a)

Complex numerals: Syncretism

(36) SCALE$_1$ $\Leftrightarrow$ /ŋe^{33}/

...

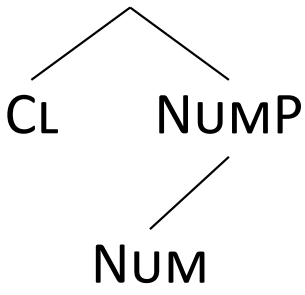
!NUMP!



NUM SCALE$_1$ $\gg$ /ŋe^{33}/

...

(37) CLP $\Leftrightarrow$ /ko^{35}/



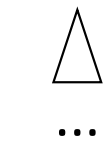
CL NUMP

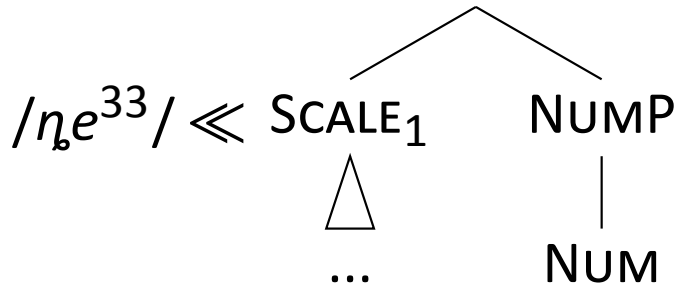
NUM

(38)
a. Spell out FP
b. If (a) fails, attempt movement of the spec of the complement of F, and retry (a)
c. If (b) fails, move the complement of F, and retry (a)

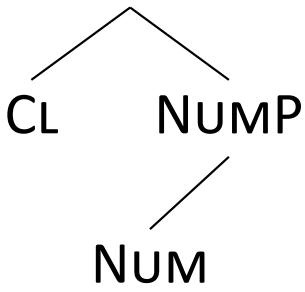
Complex numerals: Syncretism

(36) SCALE$_1$ $\Leftrightarrow$ /ŋe^{33}/





(37) CLP $\Leftrightarrow$ /ko^{35}/



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b. If (a) fails, attempt movement of the spec of the complement of F, and retry (a)
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Complex numerals: Syncretism

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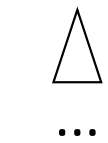
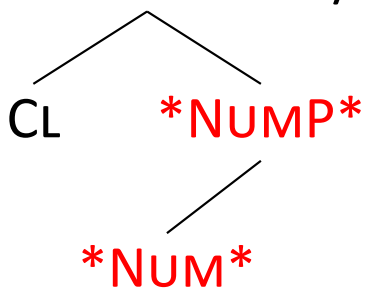
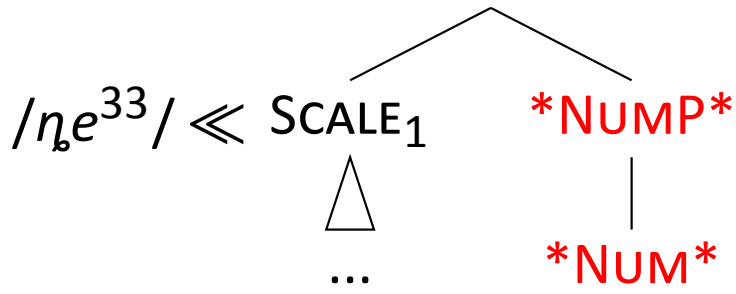


(37) CLP $\Leftrightarrow$ /ko^{35}/





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Complex numerals: Syncretism

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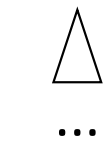
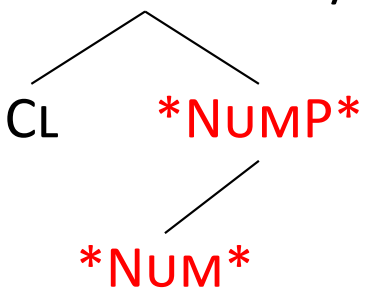
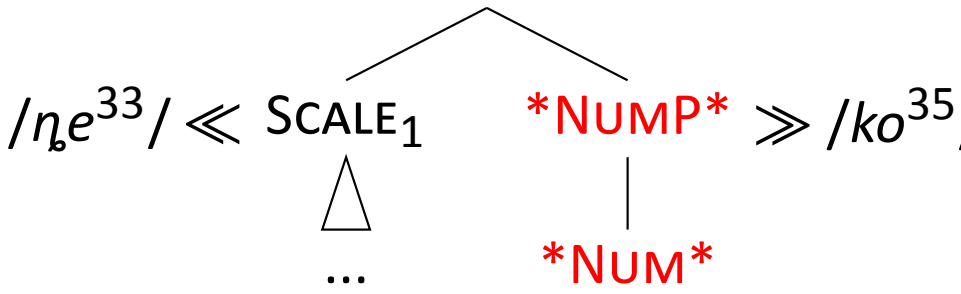


(37) CLP $\Leftrightarrow$ /ko^{35}/





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Complex numerals: Syncretism

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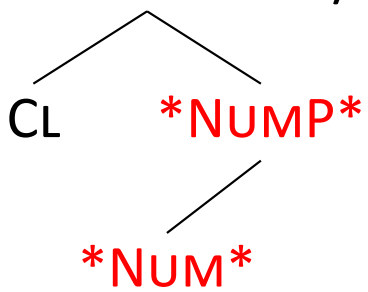
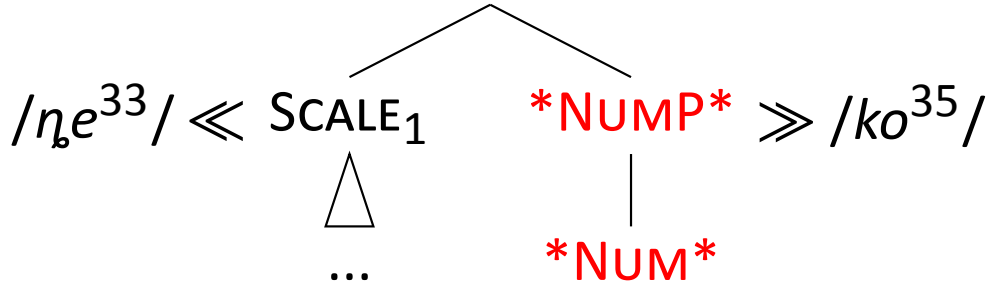
...

(37) CLP $\Leftrightarrow$ /ko^{35}/





ABSTRACT			OBJECT	
SCALE	NUM		SCALE	NUM	CL
five		ENG 5	*five*		
tnejn		MLT 2	*żewġ*		
go		JPN 5	*go*	*ko*	
ŋe^{33}	ko^{35}	SHU 1			

(38) a. Spell out FP

b. If (a) fails, attempt movement of the spec of the complement of F, and retry (a)

c. If (b) fails, move the complement of F, and retry (a)

Complex numerals: Syncretism

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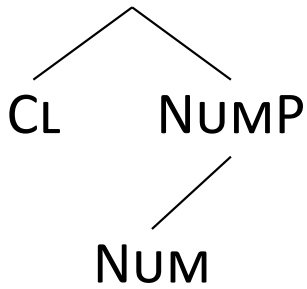
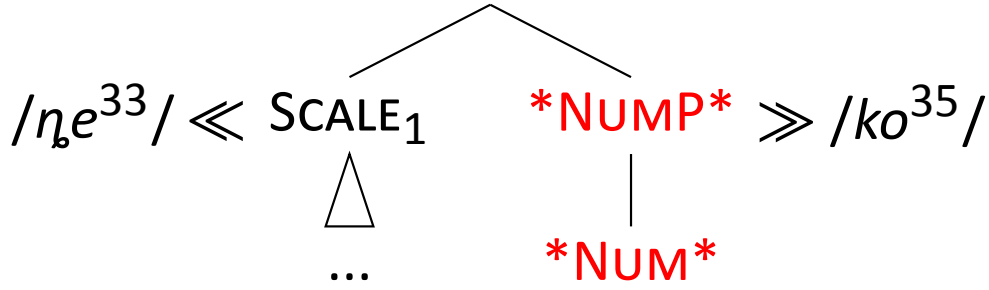
...

(37) CLP $\Leftrightarrow$ /ko^{35}/





ABSTRACT			OBJECT	
SCALE	NUM		SCALE	NUM CL
five		ENG 5	*five*	
tnejn		MLT 2	*żewġ*	
go		JPN 5	*go*	*ko*
ŋe^{33}	ko^{35}	SHU 1	???	

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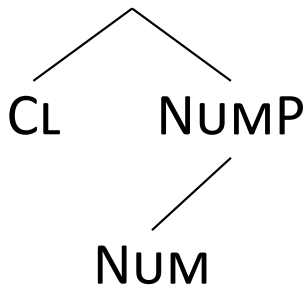

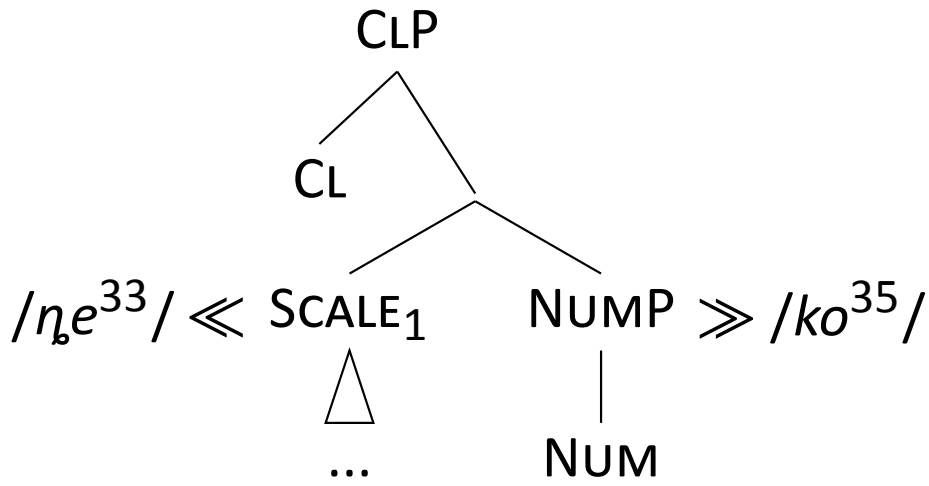

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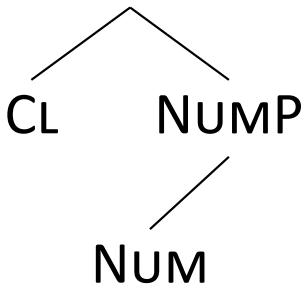

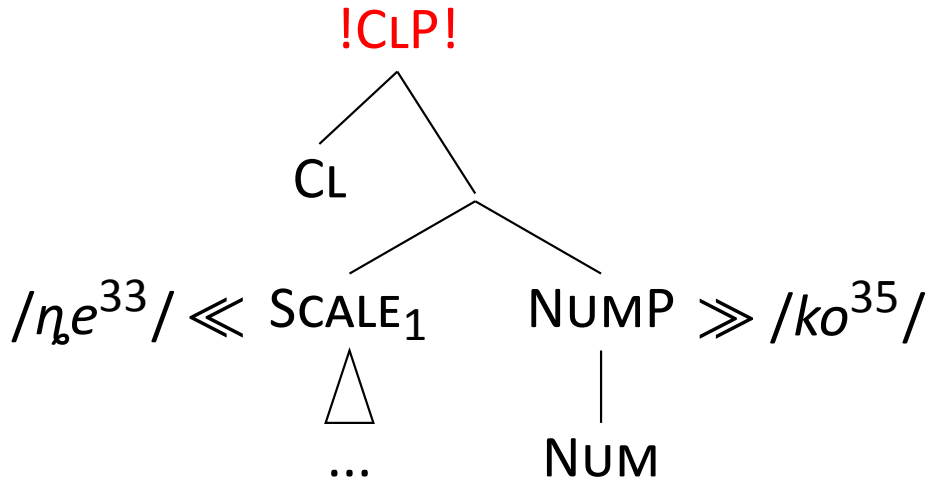

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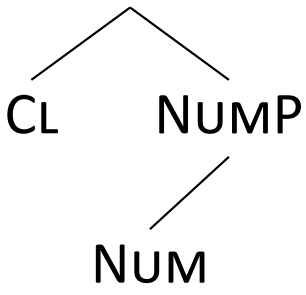
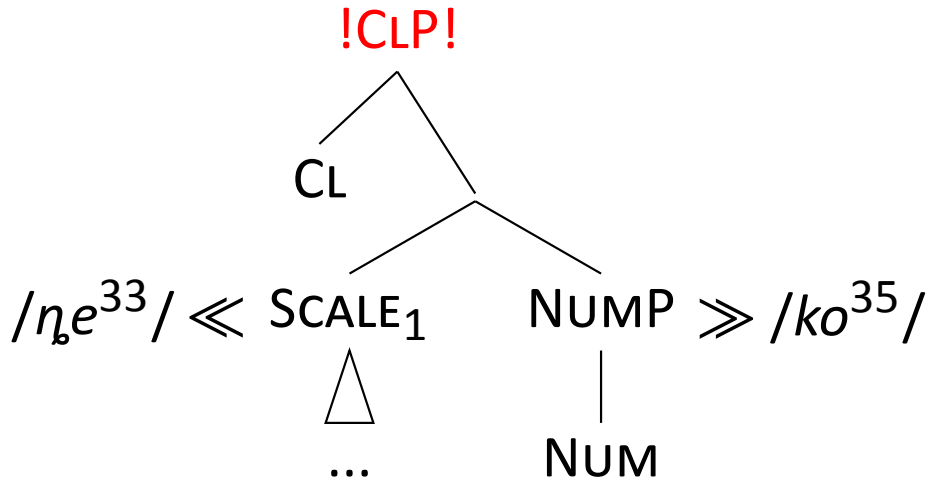
(37) CLP $\Leftrightarrow$ /ko^{35}/





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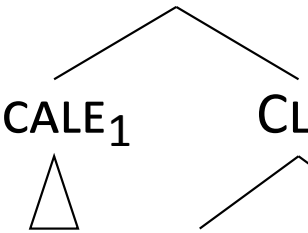
Complex numerals: Syncretism

(36) SCALE$_1$ $\Leftrightarrow$ /ŋe^{33}/

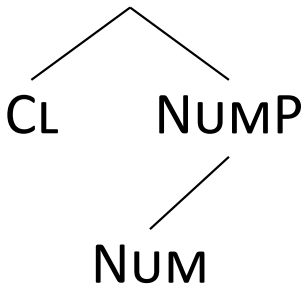
/ŋe^{33}/ $\ll$ SCALE$_1$ CLP



$\gg$ /ko^{35}/

NUM

(37) CLP $\Leftrightarrow$ /ko^{35}/



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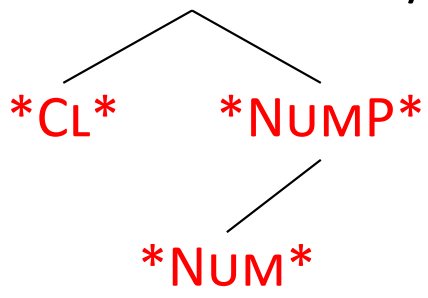
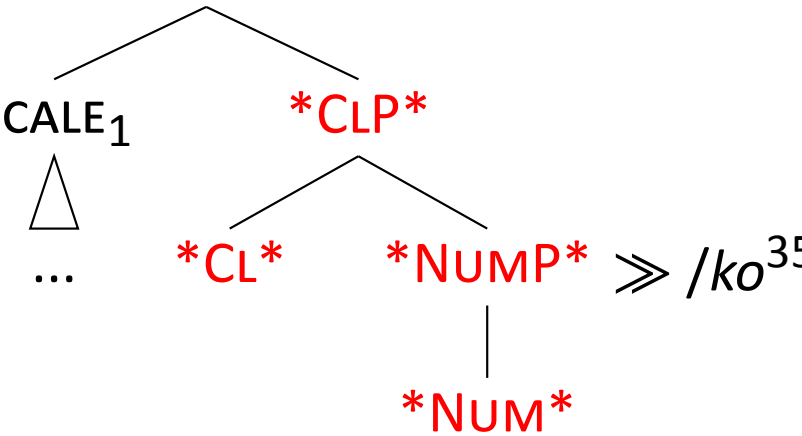
Complex numerals: Syncretism

(36) SCALE$_1$ $\Leftrightarrow$ /ŋe^{33}/

(37) *CLP* $\Leftrightarrow$ /ko^{35}/



/ŋe^{33}/ $\ll$ SCALE$_1$ *CLP* $\gg$ /ko^{35}/



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Complex numerals: Syncretism

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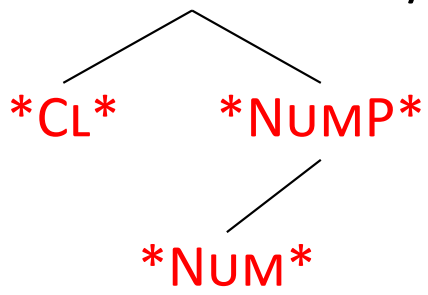
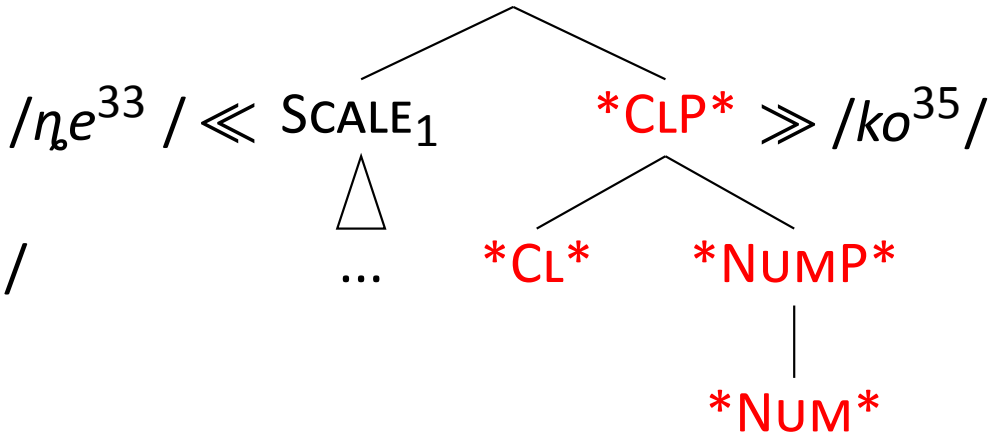
(37) *CLP* $\Leftrightarrow$ /ko^{35}/





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Complex numerals: Syncretism

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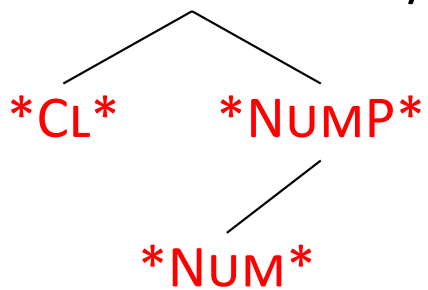
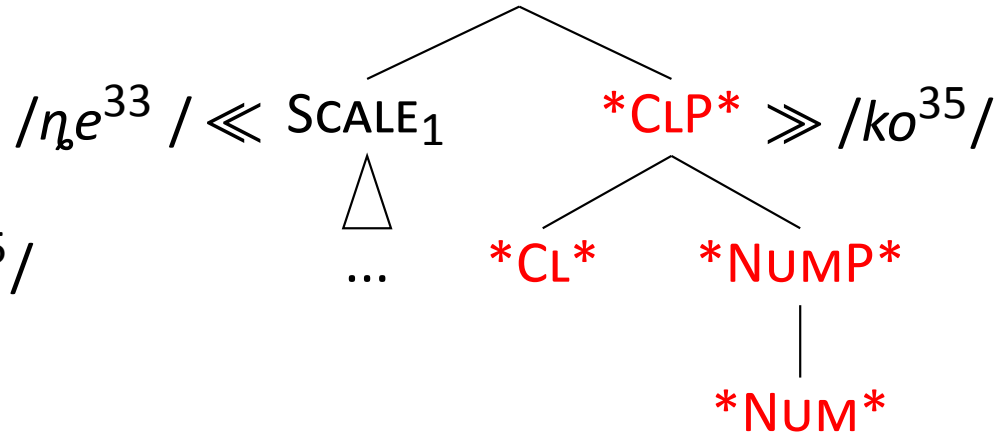
...

(37) *CLP* $\Leftrightarrow$ /ko^{35}/





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SCALE	NUM		SCALE	NUM	CL
five		ENG 5	*five*		
tnejn		MLT 2	*żewġ*		
go		JPN 5	*go*		*ko*
ŋe^{33}	*ko*^{35}	SHU 1	*ŋe*^{33}	ko^{35}	

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Complex numerals: Suppletion

ABSTRACT			OBJECT		
SCALE	NUM		SCALE	NUM	CL
five		ENG 5	*five*		
tnejn		MLT 2	*żewġ*		
go		JPN 5	*go*		*ko*
dʑi^{33}	*ko*^{35}	SHU 1	*dʑi*^{33}	*ko*^{35}	
x°	*ba*	ABKH 5	*x°*	j°ə́(k’)	

Complex numerals: Suppletion

ABSTRACT			OBJECT		
SCALE	NUM		SCALE	NUM	CL
five		ENG 5	*five*		
tnejn		MLT 2	*żewġ*		
go		JPN 5	*go*		*ko*
dʑi^{33}	*ko*^{35}	SHU 1	*dʑi*^{33}	*ko*^{35}	
x°	*ba*	ABKH 5	*x°*	j°ə́(k’)	

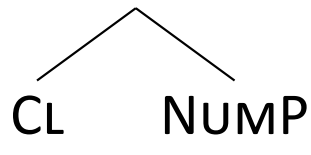
(39) SCALE$_5$ $\Leftrightarrow$ /*x°*/

...

(40) NUMP $\Leftrightarrow$ /*ba*/

NUM

(41) CLP $\Leftrightarrow$ /*j°ə́(k’)*/



CL NUMP

NUM

Complex numerals: Stacking

ABSTRACT			OBJECT		
SCALE	NUM		SCALE	NUM	CL
five		ENG 5	*five*		
tnejn		MLT 2	*żewġ*		
go		JPN 5	*go*		*ko*
dʑi^{33}	*ko*^{35}	SHU 1	*dʑi*^{33}	*ko*^{35}	
x°	*ba*	ABKH 5	*x°*	j°ə́(k’)	
ruō	*vō*	VER 2	*ruō*	*vō*	*ne*

Conclusion

Question

- what is the relationship between object-counting and abstract-counting numerals?

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- object-counting numerals both syntactically and semantically contain abstract-counting numerals!

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- universal underlying structure: [CL [NUM SCALE]]

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- universal underlying structure: [CL [NUM SCALE]]
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- universal underlying structure: [CL [NUM SCALE]]
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Typology

- variation in the complexity of numerals reduces to lexical items

Conclusion

Question

- what is the relationship between object-counting and abstract-counting numerals?

Answer

- object-counting numerals both syntactically and semantically contain abstract-counting numerals!

Proposal

- universal underlying structure: [CL [NUM SCALE]]
- lexical items pronounce structures built out of semantic atoms

Typology

- variation in the complexity of numerals reduces to lexical items
- the crucial factor is how many meaning components each morpheme pronounces

Thanks to

Informants and consultants

- Mary Chimaobi Amaechi, Alan Bale, Albert J. Borg, Lisa Bylinina, Viacheslav Chirikba, Jessica Coon, Flóra Lili Donáti, Maia Duguine, Abdelkader Fassi Fehri, Andreas Haida, Nina Haslinger, Dominika Kuruncziová, Chang Liu, Catriona Malau, Roumyana Pancheva, Marina Pantcheva, Pittayawat Pittayaporn, Dolf Rami, Bridget Schvarcz, Yasu Sudo, Peter Sutton, Tue Trinh, Kazuko Yatsushiro

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Thanks!