Putting parts of numerals together

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The goal. This paper showcases the spellout-driven movement technology developed recently in Nanosyntax (Starke 2018). It is an elaboration of the LCA-based approach (Cinque 2005). The crucial difference is that the movements required in Cinque's system are not driven by features, but by the need to spell out. This eliminates many of the objections raised against Cinque-style theories in Abels and Neeleman (2012). We will illustrate the approach by focusing on the morphology of numerals from a cross-linguistic perspective.
Data. Cardinals can have two different functions: ABSTRACT COUNTING, see (1), and OBJECT COUNTING, see (2) (Rothstein 2017). Languages often distinguish these functions morphologically (Hurford 1998). Table 1 gives four formal relations between the two uses. Symmetric numerals have one form for both functions whereas asymmetric numerals employ an additional morpheme in the object-counting function. Simple symmetric numerals are monomorphemic while complex symmetric numerals in Shuhi consist of two morphemes (Qi and He 2019). Complex asymmetric numerals in Vera'a are bimorphemic in the abstract-counting use and add two affixes to the root in the object-counting use (Schnell 2011). In all non-monomorphemic numerals, additional morphemes can appear as prefixes or suffixes.
Universal semantic features. We propose three syntactic heads in (3)–(5). SCALE$_m$ is a closed interval, e.g., the set of natural numbers $[0, 4]$. NUM takes a set of integers and forges a proper name of a number concept. CL takes a number and returns a counting device equipped with the pluralization operation * (Link 1983) and the measure function $\#(P)$ (Krifka 1989).
Composition. Combining (3)–(5) yields the structures in (6)–(7). In (6), MAX turns the interval $[0, 4]$ into the integer 4 (type n). (7) is an object-counting modifier which when applied to a predicate, yields a set of pluralities with the relevant property whose cardinality is 4.
Spellout. To account for the ordering patterns, we adopt the nanosyntactic view that lexical entries link morphemes to non-trivial syntactic structures. We assume the Superset Principle which allows a given morpheme to pronounce *any sub-constituent* contained in its entry (Starke 2009) along with the Spellout and Spec Formation algorithms in (8)–(9) (Starke 2018). This allows us to derive different morpheme orderings spelling out (3)–(5). Furthermore, a tree like (7) can also pronounce (6) since this structure is its sub-constituent.
Typology. The proposed system accounts for the attested variation by treating different types of numerals as lexicalizations of different structures derived from the universal semantic components, see Table 2. Simple symmetric numerals are stored as complete structures pronouncing all three heads, which allows them to cover both functions. Simple asymmetric numerals lexicalize only the abstract-counting meaning, and thus require additional morphology in order to be able to be used as modifiers, e.g., a classifier. In complex symmetric numerals the root is stored as SCALE$_m$ while an additional affix is a portmanteau for CL and NUM. Finally, in comlex asymmetric numerals each morpheme pronounces one of the three heads.

(1) Two times two is four.

(2) four apples

(3) $[\![\textsc{Scale}_m]\!]_{\langle n,t\rangle} = \lambda n_n[0 \leq n \leq m]$

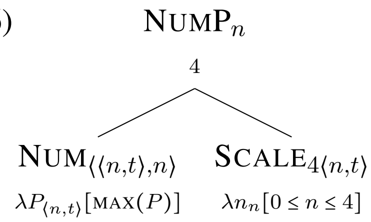
(4) $[\![\textsc{Num}]\!]_{\langle\langle n,t\rangle,n\rangle} = \lambda P_{\langle n,t\rangle}[\textsc{max}(P)]$

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

Table 1: Morphological marking patterns

LANGUAGE	NUMBER	ABSTRACT COUNTING	OBJECT COUNTING	TYPE
English	4	*four*	*four*	simple symmetric
Japanese	4	*yon*	*yon-ko*	simple asymmetric
Shuhi	1	*ʥi*^{33}*-ko*^{35}	*ʥi*^{33}*-ko*^{35}	complex symmetric
Vera’a	2	*vō-ruō*	*ne-vō-ruō*	complex asymmetric

(6)



(7)

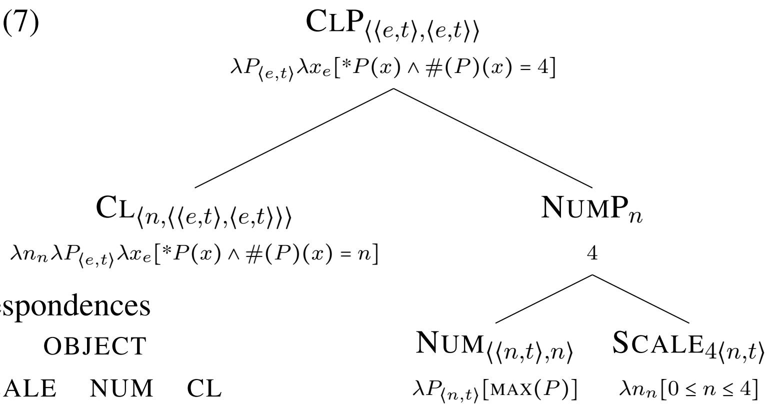


Table 2: Meaning/form correspondences

<table>
<tr><th colspan="2">ABSTRACT</th><th></th><th colspan="3">OBJECT</th></tr>
<tr><th>SCALE</th><th>NUM</th><th></th><th>SCALE</th><th>NUM</th><th>CL</th></tr>
<tr><td colspan="2">four</td><td>English 4</td><td colspan="3">four</td></tr>
<tr><td colspan="2">yon</td><td>Japanese 4</td><td colspan="2">yon</td><td>ko</td></tr>
<tr><td>ʥi^{33}</td><td>ko^{35}</td><td>Shuhi 1</td><td>ʥi^{33}</td><td colspan="2">ko^{35}</td></tr>
<tr><td>ruō</td><td>vō</td><td>Vera’a 2</td><td>ruō</td><td>vō</td><td>ne</td></tr>
</table>

(8) Merge F and: 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).

(9) Spec Formation
If Merge F has failed to spell out (even after backtracking), try to spawn a new derivation providing the feature F and merge that with the current derivation, projecting the feature F at the top node.

Keywords: numerals, morphosemantics, Nanosyntax

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Word count: 494 words