Semantics for numerals in Lalo Yi

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1. Introduction

Numerals in English are shiftable between GQs and predicates (Partee 1987; Landman 2004.) And they also have the corresponding nominalized counterparts, i.e. being singular terms (Rothstein 2013).

(1) a. \(\text{||three||}_GQ = \lambda P \lambda Q. |P \cap Q|=3\)
   
b. \(\text{||three||}_\text{Pred} = \lambda x. |x|=3\)
   
c. \(\text{||three||}_\text{Mod} = \lambda P \lambda x. P(x) \land |x|=3\)

(2) \(\text{||three||}_GQ = \lambda x. |x|=3\)

Nonetheless, it is not straightforward to what extent the type-shifting principles for English numerals proposed in Partee (1987) and Rothstein (2013) are applicable in languages beyond Europe. At least, they cannot be applied to numerals in classifier languages, whose numerals are either mapped onto singular terms (in Chinese) or predicates (in Korean) and they are not shiftable (Li 2021).

This study looks into the usages of numerals in Lalo Yi, a Loloish language (the Tibeto-Burman family) spoken in Yunnan Province, China.
Lalo Yi features two numeral systems, including numerals native to Yi and numerals borrowed from Chinese. They are confined in two sets of syntactic contexts, as exemplified by examples from (3) to (5).

First, Chinese numerals can be used in bare forms in argumental positions, but numerals native to Yi cannot be used unless they are accompanied by a classifier.

(3) ‘I can count from one to ten.’
   a. Bare Chinese numerals (borrowed)
      \[\eta^{55} \, z\hat{i}^{13} \, d\hat{z}\hat{i}^{55}a^{31}a^{33} \, s\hat{i}^{13} \, g\hat{u}^{55} \, t\hat{e}^{b}i^{55}\eta^{55} \, a^{31}.\]
      I one LOC-STATE-RES-PRT ten count to can SFP
   b. Num-Cl in Lalo Yi (native)
      \[\eta^{55} \, t\hat{s}^{b}\hat{i}^{33}(m\hat{a}^{55}) \, d\hat{z}\hat{i}^{55}a^{31}a^{33} \, t\hat{e}^{b}i^{55}(m\hat{a}^{55}) \, g\hat{u}^{55} \, t\hat{e}^{b}i^{55}\eta^{55} \, a^{31}.\]
      I one-CL LOC-STATE-PAR ten-CL count to can SFP

Second, Lalo Yi is characterized as a classifier language, whose counting predicate must be expressed by the phrase Num-Cl but not by bare numerals.

(4) a. Numerals native to Yi
    \[\tau\hat{s}\hat{a}^{55} p^{b}\hat{i}^{33}k\hat{u}^{55} \, z\hat{e}^{33}m\hat{e}^{31} \, j\hat{t}\hat{u}^{33}(m\hat{a}^{55}) \, t\hat{s}^{b}\hat{u}^{55} n\hat{i}^{33} z\hat{o}^{55}p\hat{a}^{31} k\hat{d}^{b}o^{31}(m\hat{a}^{55}) \, t\hat{s}^{b}\hat{u}^{55} \, m\hat{u}^{31}.\]
    photo-Loc girl four-CL have and boy six-CL have VIS
    ‘In the photo, girls are four and boys are six.’
   b. Numerals borrowed from Chinese
    \[\tau\hat{s}\hat{a}^{55} p^{b}\hat{i}^{33}k\hat{u}^{55} \, z\hat{e}^{33}m\hat{e}^{31} \, j\hat{s}\hat{e}^{55}(k\hat{a}^{55}) \, t\hat{s}^{b}\hat{u}^{55} n\hat{i}^{33} z\hat{o}^{55}p\hat{a}^{31} l\hat{u}^{33}(k\hat{a}^{55}) \, t\hat{s}^{b}\hat{u}^{55} \, m\hat{u}^{31}.\]
    photo-Loc girl four-CL have and boy six-CL have VIS
    ‘In the photo, girls are four and boys are six.’

Third, as Bu and Liu (2020) reported, the phrase Num-Cl cannot form a constituent with nouns in Lalo Yi, but its demonstrative phrases can be expressed as N-Dem-Num-Cl.

(5) a. \[m^{55}k\hat{u}^{55} \, a^{55}n\hat{u}^{31} \, h\hat{a}^{55} \, n\hat{u}^{31}k\hat{d}\hat{u}^{55} \, d\hat{z}\hat{a}^{31} k\hat{i}^{33} \, a^{31} \, m\hat{u}^{31}.\]
    field-Loc cow crops two CL eat PROG SPF VIS
    ‘Two cows are eating the crops in the field.’
   b. \[a^{55}n\hat{u}^{31} \, n\hat{a}^{55} \, n\hat{u}^{31}k\hat{d}\hat{u}^{55} \, m^{55}k\hat{u}^{55} \, h\hat{a}^{55} \, d\hat{z}\hat{a}^{31} k\hat{i}^{33} \, a^{31} \, m\hat{u}^{31}.\]
    cow that two CL field-Loc crops eat PROG SPF VIS
    ‘Those two cows are eating the crops in the field.’

Questions concerning the semantics of numerals in Lalo Yi:
- How are the two set of numerals in Lalo semantically distinguished?
- How would the presence of classifiers after numerals constrain the semantics of numerals in classifier languages like Lola Yi?
- Why would Num-Cl behave differently between indefinite and definite phrases?
2. **Theoretical background: A Fregean semantics for numerals in English**

The current wisdom on the semantics for numerals has been built upon the data of Indo-European languages like English, German or Russian, among others (Landman 2004; Hofweber 2005; Moltmann 2013, 2017; Ionin and Matushansky 2006). Two of the controversies on the semantics of numerals in these languages are as follows:

(i) English numerals are characterized with a family of readings, but it is highly controversial as to which reading is taken to be default, from which the other readings are derived.

(ii) There are opposed views concerning the issue of how the first-order properties denoted by numerals can be related to their nominalized counterparts, such as being ‘singular terms’ in the sense of Frege (1884)?

It has been observed by many (Moltmann 2013, 2017; Rothstein 2013, 2015; Snyder 2017; Bylinina and Nouwen 2020) that numerals in English are used in a wide range of contexts, ranging from being a determiner to a predicate or a predicate modifier, as exemplified by (6).

\(8\) a. *Eight* GQ planets are discovered.

b. The planets are *eight* Predicate.

c. There are *eight* Modifier planets.

There is not much morphosyntactic evidence available in English to favor one analysis over the others. It is theoretically possible to shift among these three readings via the “Partee triangle” (1987). There are three semantic analyses available, including the GQ view (Barwise and Cooper 1981; Hofweber 2005), the adjectival view (Moltmann 2013; Landman 2004), and the modifier view (Ionin and Matushansky 2006).

\(8\) a. eight (planets, \(\{x: x\text{ are discovered}\}\)) (numerals as GQs)

b. \(\exists x [\text{planets}(x) \land \text{eight}(x)]\) (numerals as predicates)

c. \(\exists x [\text{eight(planets)}(x)]\) (numerals as modifiers)

Among these three accounts, the analysis of numerals as GQs has been refuted by many:

- **Krifka (1999):** at least some determiners are not determiners.

Unlike other determiner phrases, indefinite phrases expressed by numerical expressions are scopeless. Numerals like *three* and *seven* in (6) have a cumulative reading, which is not predicted by the GQ analysis.

\(8\) a. Three boys ate seven apples.

b. At least three boys ate at least seven apples.

It is thus suggested that numerical expressions like *three* or *at least three* are analyzed as an adjective that applies to sum individuals which consist of (at least) three atoms.
Landman (2004): numerals are adjectives

Argument 1: numerical expressions can be taken as complement by other determiners.

(9) a. every three student
b. the three students

Argument 2: the phrase “the \(rn\) N”, such as the more than 3 students, has the structure of [the \([rn\ N]]\), where complex numeral phrases are predicates. The relation \(r\) can be expressed by \(\geq\) (more than), = (exactly), \(\leq\) (less than) …

(10) \(\|rn\|:\lambda x.\ |x|\ r\ n\), such that it denotes the set of sums whose cardinality stands in relation \(r\) to number \(n\).

Frege (1884): numerals can be used as ‘singular terms’.

The number word eight in (11) is used in an “identity sentence” (in the form of ‘A is B’, Higgins 1976), where it has the same status as the referential expression the number of planets (see Synder 2018 and Moltmann 2017 for an opposed view). They are supposed to refer to the same object, i.e. being the mathematic object 8.

(11) The number of planets is eight.

Rothstein (2013): cardinal numerals start out with a standard modifier interpretation at type \(<e,t>\), with the cardinality function defined in (12a), and it can also denote the individual property correlate of the set, namely, being a singular term, as shown in (12b).

(12) a. \([four]_{<e,t>} = \lambda x.\ |x|=4\)
b. \([four]_{<o>} = \cap (\lambda x.\ |x|=4)\)

Generalization 1: Numerals in English are interpreted as cardinal predicates.

Generalization 2: Numerals can be shifted from its predicative type into the corresponding arguments, i.e. being singular terms.

3. Numerals in Lalo Yi: an overview

This section examines the usages of numerals in Lalo Yi. We will show that the Fregean semantics for English numerals cannot be extended to numerals in Lalo Yi. We endorse the argumentation that numerals do not have a unified semantics both across and intra linguistically.

Lalo Yi features two sets of numerals, including numerals native to Lalo Yi and numerals borrowed from Chinese (Table 1). We propose that the borrowed numerals from Chinese denote singular terms, and native numerals are mapped onto GQs in Lalo Yi.

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<td>lu³¹</td>
<td>te³¹</td>
<td>pa³¹</td>
<td>teiu³¹</td>
<td>si³¹</td>
<td>…</td>
</tr>
</tbody>
</table>

Table 1. The two sets of numerals in Lalo Yi
We now show that the two sets of numerals in Lalo Yi can be distinguished in the following contexts.

- **Fact (1): native numerals in Lalo Yi cannot be used as numerical objects, but borrowed numerals from Chinese can.**

As shown in (13), the native Yi numerals ʂʰi³¹ ‘one’ and nu³³ ‘two’ cannot be predicated of the properties of being a singular number and of being a dual number, but the Chinese numerals zi¹³ ‘one’ and ʔɛ⁵⁵ ‘two’ can.

(13) One is a singular number and two is a dual number.

\[
\begin{align*}
\text{a. } & ʐʰi³¹ \text{ ka}^{33} \text{ tan}^{35} \text{ su}^{55}, \quad nu^{33} \text{ ka}^{33} \quad \text{ʂuan}^{33} \text{ su}^{55}. \quad \text{(Yi)} \\
& \text{one TOP singular numeral two TOP dual numeral} \\
\text{b. } & zi^{13} \text{ ka}^{33} \text{ tan}^{35} \text{ su}^{55}, \quad ʔɛ^{55} \text{ ka}^{33} \quad \text{ʂuan}^{33} \text{ su}^{55}. \quad \text{(Chinese)} \\
& \text{one TOP singular numeral two TOP dual numeral}
\end{align*}
\]

In the same vein, only Chinese numerals can be used in arithmetic contexts, and the use of Yi numerals is highly restricted. Instead of using bare numerals, they must take the form Num-Cl when making addition and subtraction. Multiplication and division cannot be expressed by Yi numerals at all.

(14) **Chinese numerals in arithmetic contexts**

\[
\begin{align*}
\text{a. } & Q: zi^{13} \text{ tca}^{33} \text{ ?e}^{55} \quad a^{13} \text{ da}^{55} \text{ ma}^{39} \text{ si}^{31} ? \\
& \text{one plus two how many-CL} \\
& \text{Q: ‘One plus two, it is how many?’} \\
& \text{A: zi}^{13} \text{ tca}^{33} \text{ ?e}^{55} \text{ ka}^{33} \text{ san}^{33}. \\
& \text{one plus two TOP three} \\
& \text{A: ‘One plus two makes three.’ } \\
\text{b. } & Q: ʂʰi^{13} \text{ tɕin}^{31} \text{ tɕi}^{11} \quad a^{11} \text{ da}^{55} \text{ ma}^{39} \text{ si}^{31} ? \\
& \text{ten minus nine how many-CL} \\
& \text{Q: ‘Ten minus nine, it is how many?’} \\
& \text{A: ʂʰi}^{13} \text{ tɕin}^{31} \text{ tɕi}^{11} \text{ ka}^{33} \text{ zi}^{13}. \\
& \text{ten minus nine TOP one} \\
& \text{A: ‘Ten minus nine makes one.’}
\end{align*}
\]

(15) **Native Yi numerals in arithmetic contexts**

\[
\begin{align*}
\text{a. } & tʰi^{31} \text{ ma}^{55} \text{-ku}^{55} \text{ tse}^{13} \quad ʐʰi^{31} \text{ ma}^{55} \quad ki^{3} \text{ tɕi}^{55} \text{ ka}^{33} \quad a^{13} \text{ da}^{55} \text{ ma}^{39} \text{ si}^{31} ? \\
& \text{one-Cl-Loc again one-Cl put into Gerund how many-CL} \\
& \text{‘To put one with another one, it is how many?’ (Literal: 1+1=? )} \\
\text{b. } & nu^{13} \text{ ma}^{55} \text{-ku}^{55} \quad ʐʰi^{31} \text{ ma}^{55} \quad vu^{55} \text{-a}^{4} \text{ tɕi}^{55} \text{ ka}^{33} \quad tse^{13} \quad a^{13} \text{ da}^{55} \text{ ma}^{39} \text{ si}^{31} ? \\
& \text{Two-Cl-Loc one-CL take-PFV Gerund again how many-CL} \\
& \text{‘To take one from the two, it is how many?’ (Literal: 2-1=? )}
\end{align*}
\]

- **Fact (2): the two sets of numerals in Lalo Yi are involved in two modes of counting.**

We can either directly count natural numbers or count individuals by mapping them to natural numbers. In the former only Chinese numerals can be used, and in the latter, native Yi numerals...
Rothstein (2013): the predicate counting (up) to... applies to argumental expressions, which is taken as evidence in support of the status of numerals as singular terms.

(16) a. He can count up to 13.
   b. # He can count up to 13 students.

However, in Lalo Yi, the counting context construed by count up to ... applies to borrowed numerals from Chinese, but not to native Yi numerals, unless they are accompanied by classifiers, such as the general classifier ma.

(17) ‘I can count from one to ten: one, two...’

a. Bare numerals in Chinese
   I   one LOC-STATE-RES-PRT  ten count to can SFP one two ...

b. Num-Cl in Lalo Yi
   I   one-CL LOC-STATE-PAR ten-CL count to can SFP one-CL two-CL ...

We suggest that the two sets of numerals in Lalo Yi used in the context of counting in (15) are enumerations with two distinct domains:

- Counting w.r.t the domain of natural numbers $\omega_n$ for Chinese numerals:
  - The example (18a) is a purely mathematic counting with respect to the ordering of natural numbers

- Counting w.r.t. the domain of countable individuals $\omega_e$ for native numerals in Lalo Yi:
  - In the example (18b), there is a mapping from N to S, i.e. from the set of natural numbers to the set of discrete entities.

Fact (3): neither native Yi numerals nor Chinese numerals cannot be used as predicates. Both sets of numerals can be used in predicates only when they are accompanied by classifiers.

The sentences in (18) and (19) provide a predicative position for numerical expressions, where neither the native Yi numerals nor the borrowed Chinese numerals become possible in their bare forms. Only the expression Num-Cl is licensed in this context.

(18) a. ꜟi⁶nu⁴⁴ ꜟi⁴⁴t高新技术 ꜟi⁴⁵ta⁴⁵ he⁴⁵ AtPath AtPath ꜟi⁴⁵ ꜟi⁴⁵a⁴⁵ AtPath ꜟi⁴⁵ma⁴⁵. (Num-Cl in Lalo Yi)
   today   students ask for leave NMLZ three-CL
   ‘The students who asked for leave today is three.’

b. ꜟi⁶nu⁴⁴ ꜟi⁴⁴t高新技术 ꜟi⁴⁵tea⁴⁵ a⁴⁵ san⁵⁴ma⁴⁵. (Num-Cl in Chinese)
   today   students ask for leave NMLZ three-CL
   ‘The students who asked for leave today is three.’
In the photo, girls are four and boys are six.

In the photo, girls are four and boys are six.

<table>
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<td>Native Yi nums</td>
<td>NO</td>
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</tr>
</tbody>
</table>

Table 2. Usages of numerals in English and Lalo Yi

**Generalization:** English numerals can be seen as numerical adjectives at type \(<e,t>\), Chinese numerals are mapped onto singular terms at type n, but native numerals in Lalo Yi are neither predicate nor singular terms. What is their semantic type then?

### 4. Semantics for numerals in Lalo Yi

#### 4.1 GQ analysis for native numerals in Lalo Yi

In classifier languages we are familiar with such as Mandarin and Japanese, numeral classifiers are often found in the context of Num-Cl-N or N-Num-Cl, depending on whether nominal phrases are parameterized with a head-initial order or a head-final order.

- **Bale and Coon (2014):** it is still under debate whether numeral classifiers are required by numerals or by nouns.

- **Classifiers are needed by numerals in Lalo Yi:** native numerals in Lalo Yi must be used with the accompaniment of classifiers in all the possible syntactic contexts and Num-Cl can be used independent of nouns.

- **Bu and Liu (2020):** the constituent of Num-Cl in Lalo Yi does not form a constituent with nouns, regardless of whether the noun is intended to be interpreted as subject or object.

  ◆ Evidence 1: the constituent Num-Cl behaves like a floating quantifier, which can be separated from NPs by adverbials or some other NPs.

  (20) a. a⁵⁵ni⁵⁵za³¹ ya³¹hen⁵⁵ ʔlu³³ma⁵⁵nu⁵⁵ ki³³ a³¹ mu³¹.
  
  ‘Four kids are crying sadly.’

  b. mi⁵⁵-ku⁵⁵ a⁵⁵nu¹³ ha⁵⁵ nu⁵⁵-kh⁵⁵ dza³¹ ki³³ a³¹ mu¹³.
  
  ‘Two cows are eating the crops in the field.’

  ◆ Evidence 2: it is also impossible to conjoin to NumPs. Expressions like [[N-Num-Cl and N-Num-Cl] VP] are not possible.
(21) a. * a₅₅mu₁₃ pi₁₃ nu₃₁ ts₁₁ le₃₃ thi₃₁ u₃₁ sa₅₅ pen₁₃ ve₅₅ ka₃₃ la₅₅ mu₃₁.  
   Amu pen two-CL and book three CL buy back VIS  
   b. a₅₅mu₁₃ pi₁₃ nu₃₁ ts₁₁ve₅₅ ka₃₃ la₅₅ le₃₃ thi₃₁ u₃₁ sa₅₅ pen₁₃ ve₅₅ ka₃₃ la₅₅ mu₃₁.  
   Amu pen two-CL buy back and book three CL buy back VIS  
   ‘Amu bought two pens and three books’

Unfortunately, this puzzle was not solved why the phrase Num-Cl cannot merge with nouns in their account.  

**Our proposal:** native numerals in Lalo Yi are neither predicates nor singular terms but they are  
generalized quantifiers.  
- It is the classifier but not the noun that comes to saturate the restrictor associated with  
  GQs in Lalo Yi.  
- When numerals in Lalo Yi are suggested to be of type <<e,t>, <<e,t>, t>>, the first  
  argument is saturated by the subsequent classifier, and the constituent Num-Cl then takes  
  the verb as its second argument.

(22) $||ʔlɯ³³||_{<<e,t>, <<e,t>, t>>}=λPλQ.∃x.P(x) ∧ Q(x) ∧ |x|=4$

We showed earlier that one of the most robust evidence to refute the GQ analysis for English  
numerals is that its NumPs are subject to a cumulative reading. However, in Lalo Yi, its NumPs,  
**i.e. the constituent Num-Cl, have the anti-cumulativity effect.**  
Lalo Yi disallows the occurrence of double NumPs in a single sentence in a general fashion.  
And the single occurrence of Num-Cl, which sits next to the predicate, is always scope-taking.

(23) a. *z₃ⁿ pa₃¹ ?lɯ₃ᵐᵃ₅₅ la₃ᵖa₃¹ sa₃ᵐᵃ₅₅ kho₃ᶜⁱ₃ᵃₛⁱᶜⁱ₅₅ a₅₅ mu₅₅.  
   leopard four-CL tiger three-CL bite die PFV SFP VIS  
   Intended: ‘Four leopard(s) killed three tigers.’  
   b. la₃ⁿpa₃¹ sa₃ᵐᵃ₅₅ kʰₒ₃ᶜⁱ₅₅ᵃₛⁱᶜⁱ₅₅ a₅₅ zⱼⁿpₐ₃¹ ?lɯ₃ᵐᵃ₅₅.  
   tiger three-CL bite die PFV NMLZ leopard four-CL  
   ‘The leopards that killed three tigers are four.’

Given that only one occurrence of Num-Cl is allowed for a certain two-place predicate, one of its  
arguments is expressed by Num-Cl and the other is reserved for a bare noun. Although the phrase  
Num-Cl and bare nouns do not form a constituent, they can be coreferential with each other.  
Consider the example in (24).

(24) tˢʰ₅₅ la₃ⁿpa₃¹ na₃ᵐᵃ₅₅ tsa₃ˡ z₁₃ᵏʰ₅₅ a₃ˡ mu₃ˡ.  
   people tiger five-CL seek go want SFP VIS  
   a. ‘As for tigers, the people are going to feed five.’  
   Lit: ‘The people are going to seek five tigers.’  
   (seek > five tigers or five tigers > seek)  
   b. ‘As for people, five are going to seek tigers.’  
   Lit: ‘Five people are going to seek tigers.’  
   (five people <seek< tigers)
The GQ status of Yi numerals is corroborated by the following facts independently.

- **Fact 1:** there is no lexicalized quantifier like *every*, *all* or *the* in Lalo Yi. Hence, the phrase Num-Cl cannot be taken as complement of other determiners. Unlike what we saw in English, word orders like *Num-Cl-THE* or *Num-Cl-EVERY* in Lalo Yi are not available in Lalo Yi.

The distributive meaning of noun phrases is achieved by reduplicating the plural phrase Num-Cl. As a result, the form Num-Cl-Num-Cl is comparable to a distributive quantifier.

(25) a. a⁵⁵ni⁵⁵za³¹ sa³³ma⁵⁵ sa³³ ma⁵⁵ pʰin⁴⁳ko⁵⁵ tʂʰi⁵⁵ma⁵⁵ dza⁵³.
   kid three Cl three Cl apple one Cl eat
   ‘Every three kids eat one apple.’

The singular phrase ONE-Cl cannot be reduplicated to express the distributive meaning. Instead, we can employ the strategy of relative clauses, when we intend to express the meaning of *every NP*.

(26) a⁵⁵ni⁵⁵za³¹ ha⁵⁵ tʂʰi³¹ŋa⁵⁵ a⁵⁵ phin⁴³ko⁵³ dza⁵³ pe⁵⁵ a⁵⁵ mu⁵⁵.
   kid all one Cl be NMLZ apple eat PV FVF VIS
   ‘As for kids, all who is a kid, ate apples.’
   Lit: ‘Every kid ate apples.’

- **Fact 2:** degree modifiers like *more than*, *less than*, *exactly*, *around* are not available in Lalo Yi, which implies the constituent Num-Cl is not susceptible to the modification of predicative modifiers.

Instead, the Yi language may use the verb *ma³¹tʂʰi⁵⁵* ‘exceed’ and *ma³¹tɕʰi⁵⁵* ‘fall behind, be inferior’ to express the ‘comparative’ meaning ‘more than’ and ‘less than’ respectively.

(27) sʰo¹³sen³³ kʰau³¹ɕi³¹ la⁵⁵ a⁵⁵ tʂʰi³¹hã³¹ma⁵⁵ ma⁵¹tsʰi⁵³/ma³¹te⁵⁵ mu⁵⁵.
   student exam come NMLZ one-hundred-Cl exceed / not reach VIS
   ‘The students who came to sit for exam exceeded/ fell behind 100.’
   Lit: ‘More than/less than one hundred students took the exam.’

- **Fact 3:** the constituent of Num-Cl under the guise of various syntactic/phonological forms are used to express various quantificational meanings, including the distributive reading and the definite reading.

  We suggest that the apparent definite article *tʂʰi⁵³* is grammaticalized from the numeral *tʂʰi⁵³* ‘one’, which is manifested by the tone sandhi from its base tone 31 to a high-level tone 55.

  The morpheme *tʂʰi⁵³* appears to be the definite article in Lalo Yi, but it applies to singular phrases only, i.e. *[tʂʰi⁵³-Cl-N]*. It is impossible for *tʂʰi⁵³* to take Num-Cl-N as complement to express the definite reading.

(28) a. pʰa³⁵ tʂʰi⁵³ kʰe³³ tʰu⁵⁵ mu⁵³. [tʂʰi⁵³-Cl-N]
   clothes the Cl thick VIS
   ‘This item of clothes is thick.’
Semantics for native numerals in Lalo Yi

While acknowledging the analysis of the phrase Num-Cl as a generalized quantifier, it is expected that the GQ reading can be coerced into a predicative reading via standard type-shifting principles proposed in Partee (1987).

As shown earlier, Num-Cl can also be used in predicative positions. We suggest that GQs can only be shifted to predicates by the type-lowering BE, but the lowering from GQs to e is blocked and it is compensated by the Chinese numeral system instead.

\[(29)\]

\[
\text{la}^{33}\text{pa}^{31} \quad \text{sa}^{33}\text{ma}^{55} \quad \text{k}^{031}\text{ti}^{35} \quad \text{a}^{55}\text{ti}^{55} \quad \text{a}^{55} \quad \text{z}^{1}\text{pa}^{31} \quad \text{ʔlu}^{33}\text{ma}^{55}.
\]

\[
\text{tiger} \quad \text{three-Cl} \quad \text{bite} \quad \text{die} \quad \text{PFV} \quad \text{NMLZ} \quad \text{leopard} \quad \text{four-Cl}
\]

‘The leopards that killed three tigers are four.’

b. || \(\text{ʔlu}^{33}\text{ma}^{55}||=\lambda \ Q. \exists x. Q(x) \land \text{ATOM}(x) \land |x|=4
\]

c. BE \((||\text{ʔlu}^{33}\text{ma}^{55}||) =\exists x. \text{ATOM}(x) \land |x|=4)

This shifted predicative reading is also available for the Num-Cl phrase in demonstrative phrases. Although there is no definite article in Lalo Yi, demonstratives are the most suitable candidate to express definiteness. DemPs are expressed in the order of N-Dem-Num-Cl in Lalo Yi.

- **Bu and Liu (2020):** Demonstrative phrases in Lola Yi do not observe the same syntactic constraint as indefinite phrases that Num-Cl that demonstratives can in fact merge with nouns to be a quantificational phrase.

\[(30)\]

\[
\text{ŋa}^{55} \quad \text{a}^{55}\text{k}^{031} \quad \text{h}^{0} \quad \text{ɯ}^{31} \quad \text{na}^{55} \quad \text{sa}^{33}\text{ma}^{55} \quad \text{ʔvu}^{33}\text{hu}^{55} \quad \text{a}^{55}\text{ti}^{55} \quad \text{a}^{55}.
\]

\[
\text{I} \quad \text{dog} \quad \text{that} \quad \text{three-Cl} \quad \text{sell out} \quad \text{PFV} \quad \text{SFP}
\]

‘I sold out those three dogs.’

b. \(\text{a}^{55}\text{k}^{031} \quad \text{na}^{55} \quad \text{sa}^{33}\text{ma}^{55} \quad \text{ŋa}^{55} \quad \text{ʔvu}^{33}\text{hu}^{55} \quad \text{a}^{55}\text{ti}^{55} \quad \text{a}^{55}.
\]

\[
\text{dog} \quad \text{that} \quad \text{three-Cl} \quad \text{I} \quad \text{sell out} \quad \text{PFV} \quad \text{SFP}
\]

‘Those three dogs, I sold out.’

c. \(\text{a}^{55}\text{k}^{031} \quad \text{sa}^{33}\text{ma}^{55} \quad \text{ŋa}^{55} \quad \text{ʔvu}^{33}\text{hu}^{55} \quad \text{a}^{55}\text{ti}^{55} \quad \text{a}^{55}.
\]

\[
\text{dog} \quad \text{three Cl} \quad \text{I} \quad \text{sell out} \quad \text{PFV} \quad \text{SFP}
\]

Intended: ‘Three dogs, I sold out.’

We suggest that demonstratives, which provides a predicative position for its complements, are able to trigger Num-Cl to be shifted from \(<<\text{e},\text{t}>\) to \(\text{<e},\text{t}>\). The coerced Num-Cl can merge with NPs via the mechanism of predicate modification (Heim and Kratzer 1997).

\[(31)\]

\[
||\text{N-Dem-Num-Cl}||=||\text{Dem}|| (||\text{N-Num-Cl}||)=||\text{Dem}|| (||\text{Num-Cl}|| \land ||\text{N}||)
\]

Semantics for borrowed Chinese numerals

The second issue to be tackled in this section is concerned with the availability of numerals as singular terms.

According to Rothstein (2013), cardinal numerals start out with a standard modifier interpretation at type \(<\text{e},\text{t}>,\) with the cardinality function defined in (31a), and it can also denote
the individual property correlate of the set, namely, being a singular term (31b).

(32) a. \[\|\text{four}\|_{\text{e,t}} = \lambda x. |x|=4\]

b. \[\|\text{four}\|_{\text{n}} = \circ (\lambda x. |x|=4)\] (Rothstein 2013)

Till now, we’ve seen that native numerals in Lalo Yi do not have corresponding nominalized counterparts. Namely, they fail to be used as singular terms. Instead, they resort to the Chinese numerals to represent numeral as mathematic objects, which are abstracted at a higher level.

We argue that borrowed Chinese numerals are born as singular terms, which are analogous to the kind denotation of bare nouns in Chinese as proposed in Chierchia (1998). They can be coerced with a predicative meaning by lexical device, e.g. the use of classifiers, which results in the counting predicate Num-Cl.

(33) la³¹pa³¹    sa n³³ k ə⁵⁵ k ho³¹ɕi⁵⁵ a⁵⁵t ɕi⁵⁵ a ⁵ ⁵        zɿ³¹pa³¹   s i⁵⁵

‘The leopards that killed three tigers are four.’

In Lalo Yi, borrowed Chinese numerals go with borrowed Chinese classifiers. We suggest that classifiers in Chinese denote the cardinality function from natural numbers to a set of atomic individuals (Li 2021).

(34) a. \[\|\text{si}^{55}\|_n=4\]

b. \[\|k\text{a}^{55}\|_n=\lambda n\lambda x. \mu(x)=<n, \text{Unit}>\]

c. \[\|\text{si}^{55}\|_n\|=\|k\text{a}^{55}\|_n\=\lambda n\lambda x[\mu(x)=<n, \text{Unit}>] (4) = \lambda x.[\mu(x)=<4, \text{Unit}>]\]

In a word, both cross-linguistically and intra-linguistically, numerals are not endowed with a unified semantics. In Lalo Yi, the two sets of numerals diverge from each other in either serving as a functor that takes classifiers as its argument, or as an argument (e.g. being a numeric object) to saturate the variable for numeral associated with the semantics of classifiers. In these two cases, classifiers are not analyzed with a unified semantics either.

5. Some more puzzles unsolved

- **Puzzle 1:** the phrase Cl-N cannot compose with adjectival predicates as its argument. The phrase Num-Cl can only function as a predicate, which is predicated of a relativized NP.

(35) a. eo³³sen³³ sa³³-ma⁵⁵ tehin³¹tea⁵⁵ a³⁵tei⁵⁵ a⁵⁵ mu⁵⁵.

‘Three students asked for leave.’

b. *eo³³sen³³ sa³³-ma⁵⁵ (me³³) sa³¹ mu⁵⁵.

‘Intended: ‘Three students are intelligent.’

c. eo³³sen³³ (me³³) sa³¹ a⁵⁵ sa³³ma⁵⁵.

‘Students who are intelligent are three.’
It seems not highly motivated to associate the phrase Num-Cl with an event interpretation. The most I can think of is that, following Chung and Ladusaw (2001:13), the phrase Num-Cl composes with the VP via restriction, and there is also an event variable, which must be existentially closed before the closure of the restricted argument is forced at the end. But would this move makes us give up the GQ analysis for Num-Cl?

**Puzzle 2: different aspectual markers may affect the interpretation of Num-Cl to be co-referential with a subject NP or an object NP.**

According to Bu and Liu (2020), when the verb is marked by progressive or immediate future markers, the phrase Num-Cl can be co-referential with the subject or object NP; when the verb is marked by durative, experiential or perfective aspects, it can only be co-referential with the object NP.

<table>
<thead>
<tr>
<th>Subject NP</th>
<th>Object NP</th>
<th>Num-Cl</th>
<th>Verb</th>
<th>Aspect</th>
<th>Lexical source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antecedent&lt;sub&gt;a&lt;/sub&gt;</td>
<td>Antecedent&lt;sub&gt;y&lt;/sub&gt;</td>
<td>x/y</td>
<td>Progressive</td>
<td>hide (put intentionally)</td>
<td></td>
</tr>
<tr>
<td>Antecedent&lt;sub&gt;a&lt;/sub&gt;</td>
<td>Antecedent&lt;sub&gt;y&lt;/sub&gt;</td>
<td>x/y</td>
<td>Immediate future</td>
<td>want</td>
<td></td>
</tr>
<tr>
<td>Antecedent&lt;sub&gt;y&lt;/sub&gt;</td>
<td></td>
<td>y</td>
<td>Durative</td>
<td>Mandarin loanword 着</td>
<td></td>
</tr>
<tr>
<td>Antecedent&lt;sub&gt;y&lt;/sub&gt;</td>
<td></td>
<td>y</td>
<td>Experiential</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Antecedent&lt;sub&gt;y&lt;/sub&gt;</td>
<td></td>
<td>y</td>
<td>Perfective</td>
<td>?</td>
<td></td>
</tr>
</tbody>
</table>

We speculate that whether the aspectual markers are intensional or not might play a role here. Not only the immediate future marker but also the progressive marker is intensional, the latter of which means ‘to hide’, i.e. ‘to put intentionally’. However, other aspectual markers are not intensional in any case. We, following Filip (1996), assume that these aspectual markers are lexical V-operators that quantifies over episodic predicates and their argument. They bind the incremental theme argument. This makes Num-Cl a part of the predicate, which, as a consequence, leads to a narrow-scope reading.

**Selected references:**