

Approximating Number Pairs in Mandarin Chinese

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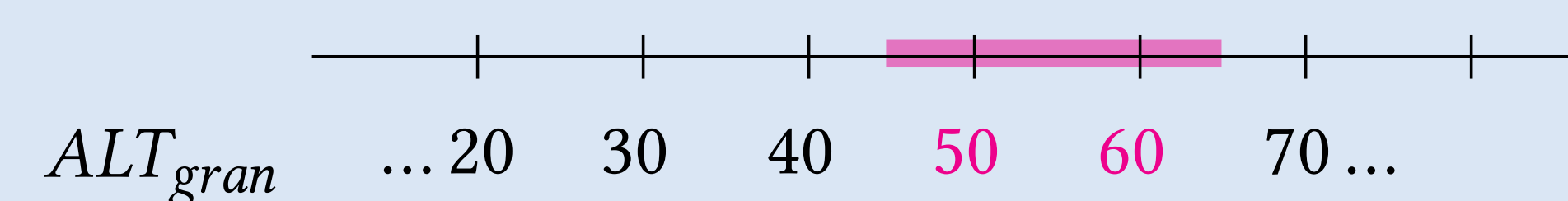
Approximating Number Pairs

- Approximating number pairs (ANPs) is a kind of range-approximation-like expression which takes a **pair of numbers** and expresses a quantity **close to the pair**.
- (1) There were **twenty or thirty** people in the hallway.
 - Not the same as $20 \vee 30$, and not just between 20 and 30.
- (2) # He ate **eleven or fifty** biscuits.
 - Not all numbers can form ANPs.
- (3) There were twenty people **or** there were thirty people here.
 - Sentential disjunctions** do not give rise to approximateness.

Two numbers in disjunction?

- How is the "quantity close to the pair" expressed?
- Solt (2018): boolean disjunction + granularity (the Ruler Model)

"Fifty or sixty" $gran = 10$ by social convention

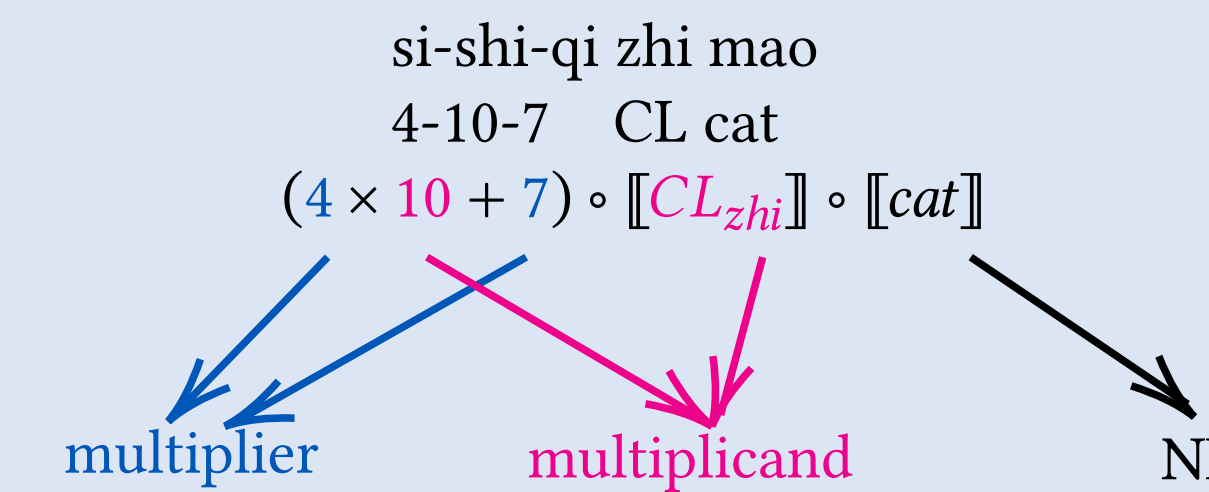


$\llbracket 50 \text{ or } 60 \rrbracket = \{ \text{numbers closer to 50 than any alternatives} \} \cup \{ \text{numbers closer to 60 than any alternatives} \}$

- Range of approximation depends on $gran$, but **how is $gran$ chosen?**
- (4) a. 30 or 45 **minutes** $gran = 15$ ok
b. # 30 or 45 **biscuits** $gran = 15$ not ok
- Mandarin Chinese (MC) data: **duplicating the base / anchor** in (5b) results in ungrammaticality; adding the **disjunction** in (5c) diminishes the approximative meaning.
- (5) a. **liang-san** -bai zhi mao
two-three- 10^2 CL cat
'Two (hundred) or three hundred cats'
b. ***liang-bai san-bai** zhi mao
two- 10^2 three- 10^2 CL cat
Intended: 'Two (hundred) or three hundred cats'
c. **liang huo san-bai** zhi mao
two or three- 10^2 CL cat
'(Precisely, either) two hundred or three hundred cats'
- Concatenated pair of simplex numerals—**single constituent?**
- Ionin and Matushansky (2006): coordination in complex numeral formation does not semantically result in boolean conjunctions, but rather in set products. (e.g. 220 cats \neq 200 cats **and** 20 cats)

The Proposal: An ANP in MC is **one**

inseparable (complex) cardinal where the **multiplier** of its final summand is a **fixed range** instead of a simplex cardinal in exact numerals.



Numeral composition in MC

- Simplex cardinals** $\{1, \dots, 9\}$; **bases / anchors** (Barlow 2025) $\{10, 10^2, 10^3, 10^4, 10^8, 10^{12}\}$; **classifiers / measure phrases** (e.g. *da* 'dozen')
- (6) si qian san bai wu shi ba
4 10^3 3 10^2 5 10 8
'four thousand three hundred and fifty-eight'
Resulting cardinality: $4 \times 10^3 + 3 \times 10^2 + 5 \times 10 + 8$
- Multiplicative** composition: a numeral denoting the cardinality $n \times m$
 - Multiplier n :** looks at the referent in n partitions
 - Multiplicand m :** each partition is of the cardinality m
 - Simplex cardinals serve as **multipliers**, bases serve as **multiplicands**
- Additive** composition (Ionin and Matushansky 2006, Heycock & Zamparelli 2000): a numeral denoting the cardinality $a+b$, where a and b are **summands**
 - syntactically a covert coordination of a and b , and
 - semantically $\lambda x. \exists y, z. (x = y \oplus z) \wedge (|y| = a) \wedge (|z| = b)$
- Classifiers can internally encode a quantity that serves as a **multiplicand** (Jiang et al., 2022); they also **type-shift** nouns: kinds into type *et* referents

	simple cardinals	bases/anchors	classifiers
Multiplier	✓	×	×
Multiplicand	×	✓	✓
Type-shifting	×	×	✓

The range is uniform for all ANPs

- Unlike the Ruler Model, which requires a specific $gran$ chosen for each instance of a numeral, this analysis uses a **uniform range R** for all ANPs. The range R serves as a **multiplier**, like a simplex numeral.
- The multiplicands (bases or classifiers) are **not** approximative.
- The range R then **multiplies** with the multiplicand, resulting in the range being scaled up accordingly.
- If $R = [\frac{-1}{2}, \frac{3}{2}]$, then the denotation of *liang bai er san shi* [2 10^2 2 3 10] 'two hundred twenty or thirty' is $\lambda x. \mu_{CARD}(x) \in [215, 235]$ ('between 215 and 235').
- (7) $\llbracket (n, n + 1) \rrbracket = \lambda m. (\lambda s. (\lambda x. \mu_{CARD}(x) \in s + (n + R) \times m))$
'The cardinality of the referent x is between $s + (n - 1/2) \times m$ and $s + ((n + 1) + 1/2) \times m$, where s is the sum of other non-approximative summands'

Other approximative expressions

- Proposal:** different approximative expressions in MC **only differ in the range and not in their compositions**.
- The range R is specific to the concrete approximative expression used but independent of the number that is being approximated.
- Luo (2018): constructions with particle *duo* 'more' exhibit different meanings with the particle attached before vs. after the classifier
- (8) a. **shi** duo bei shui
10 **(DUO)** CL_{cup} water
'Between **10 and 20** cups of water'
b. **shi** bei duo shui
10 CL_{cup} **(DUO)** water
'Between **10 and 11** cups of water'
- We only need to substitute R with the range of approximation of *duo* $R_{duo} = [0, 1]$. The range then multiplies with 10 in (8a) and with 1 (the internal quantity of CL_{cup}) in (8b).

Implication for classifier phrases

- MC classifier phrases: $[[\text{Num CL}] \text{NP}]$ or $[\text{Num} [\text{CL NP}]]$?
 - Type-shifting properties suggest $[\text{Num} [\text{CL NP}]]$ (Scontras 2013)
 - $[[\text{Num CL}] \text{NP}]$ better supported from historical word order (Her 2017)
 - Both are needed (Jiang et al., 2022)
- If we assume a uniform type for the approximative expressions in (8a) and (8b) as well as in ANPs, it seems that CL has complex semantic functions: $[[\text{Num CL}_{\langle \text{CARD} \rangle}][\text{CL}_{\langle \text{et} \rightarrow \text{et} \rangle} \text{NP}]]$
 - multiplicand-like portion $\text{CL}_{\langle \text{CARD} \rangle}$ composing with Num
 - type-shifting portion $\text{CL}_{\langle \text{et} \rightarrow \text{et} \rangle}$ composing with NP

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