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Structure of Classifiers and Measure Words: A Lexical Functional Account*

One-Soon Her
National Chengchi University

Previous accounts of the distribution of classifiers (C) and measure words (M) in Chinese [Num C/M N] include a uniform left-branching, right-branching, or split structure. This paper demonstrates that the left-branching structure best captures C/M's common properties—among others, they are unified mathematically as the multiplicand (*1* and ¬*1* respectively) — and also offers the simplest account of word order typology. By contrast, the right-branching and the split account both over-generate and under-generate. A formal account is offered within Lexical Functional Grammar. C/M share the same left-branching (constituent) c-structure but differ in (functional) f-structure, where C serves as a co-head of N, but M heads the QUANTIFIER function. The f-structure proposed reflects the insight that cognitively C, not M, serves to *profile* an essential feature of N, in the sense of Fillmore (1982), and also captures the selectional restrictions between C and N.

Key words: classifier, measure word, constituency, c-structure, f-structure, profile, multiplication

1. Introduction

Whether classifiers (C) and measure words (M) in a [Num C/M N] phrase in Chinese, as shown in (1) and (2) respectively, give rise to an identical syntactic structure or two different structures has been a rather contentious issue.

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(1) a. 一百 尾 魚
yibai *wei* *yu*
one hundred C fish
'one hundred fish'

b. 三 根 香蕉
san *gen* *xiangjiao*
three C banana
'three bananas'

c. 十 匹 馬
shi *pi* *ma*
ten C horse
'ten horses'

(2) a. 一百 箱 魚
yibai *xiang* *yu*
one hundred M-box fish
'one hundred boxes of fish'

b. 三 公斤 香蕉
san *gongjin* *xiangjiao*
three M-kilo banana
'three kilos of bananas'

c. 一 群 馬
yi *qun* *ma*
one M-herd horse
'one herd of horses'

Some studies assign C/M a unified structure, which some argue to be left-branching, or [[Num C/M] N], and others right-branching, or [Num [C/M N]]. Yet, in some syntactic accounts both structures are required for C/M. A consensus seems rather elusive. Contra syntax, a semantic distinction between C/M is nearly universally recognized. A well-cited example is Tai & Wang's (1990:38) characterization:

> A classifier categorizes a class of nouns by picking out some salient perceptual properties, either physically or functionally based, which are permanently associated with entities named by the class of nouns; a measure word does not categorize but denotes the quantity of the entity named by noun.

This paper aims to provide convincing evidence for C/M's unified left-branching structure and render a formal account within the Lexical Functional Grammar (LFG).

The paper is organized as follows. Section 2 first summarizes the distinction between C/M from semantic, cognitive, and mathematical perspectives and then documents a set of consequential formal tests to distinguish between C/M. Section 3 then moves on to demonstrate that C/M share at least seven common properties in syntactic behavior. Section 4 consists of a succinct critical review of previous syntactic accounts. A formal LFG account is offered in §5, one that captures how C/M are different as well as what they have in common. Section 6 concludes the paper with a summary.

2. C/M distinctions

This section first documents how C/M are inherently different in §2.1 and then illustrates how these differences lead to observable phenomena in §2.2.

2.1 Semantic, mathematical, and cognitive distinctions between C/M

Her & Hsieh (2010) pinpoint the distinction between C/M with Aristotle's essential vs. accidental feature.

(3) Essential vs. Accidental Property
P is an *essential property* of an object *o* just in case it is necessary that *o* has *P* whereas *P* is an *accidental property* of an object *o* just in case *o* has *P* but it is possible that *o* lacks *P*. (Robertson 2008)

Thus, in (1a), the C 尾 *wei* and the N 魚 *yu* 'fish' are compatible in that having a tail is an essential property for fish. The classifier thus only highlights a certain inherent feature of N and provides no additional information to the phrase. A measure word, e.g. 箱 *xiang* 'box' in (2a), does provide additional information to the noun: the fish are inside the box and/or mass the boxful quantity, which is an accidental property of the N. Adams & Conklin's (1973:2) insight that C's *qualify* and M's *quantify* the head noun thus receives a precise interpretation. Her (to appear) further proposes that in set-theoretic terms this simply means that the properties denoted by C constitute a subset of those denoted by N, which is not true for M.

(4) **C/M Distinction in Set-theoretic Terms** (Her to appear)
Given a well-formed phrase [Num K N], *X* the set of properties denoted by K, and *Y* the set of properties denoted by N, K=C *iff* $X \subset Y$; otherwise, K=M.

Therefore, in (5), even though *fish*, *sheep*, *chicken*, *elephant*, and *germ* may each have very different semantic content, they are all inherently animate. That they can all share the same C 隻 *zhi* is because *zhi* precisely denotes animacy.

(5) 三 隻 魚/羊/雞/大象/細菌
san zhi yu/yang/ji/daxiang/xijun
three C fish/sheep/chicken/elephant/germ
'three fish/sheep/chickens/elephants/germs'

Thus, though C may be required syntactically, C is semantically redundant in [Num C/M N]; M is not.[1] As we shall see later, this difference is central to the various different behaviors that C/M display, one of which is mathematical. Integrating insights gained from the concepts of parceler (Landman 2004), divider (Borer 2005), and multiplicand (Au Yeung 2005, 2007), Her & Lai (to appear) and Her (to appear) propose that the relation between Num and C/M can be seen as *multiplier* and *multiplicand*.[2] Crucially, C/M are unified under the notion of multiplicand and yet with distinct values: C's value is necessarily *1* and M ¬*1*.

(6) **C/M Distinction in Mathematics**
[Num $\underline{K}$ N] = [Num×$\underline{k}$ N], where K=C *iff k=1*, otherwise K=M.

Multiplication is a fundamental operation in the number system, which is strictly regular in Chinese and follows this nearly universal pattern [($n \times base$) + m, *where* $m < base$] (Comrie 2006, 2011). In its 3000 years of recorded history, numbers in Chinese have consistently followed this pattern. A high number round figure, e.g. 九千 *jiu-qian* '9000' and 六十 *liu-shi* '60', employs the simple multiplication [$n \times base$], e.g. [*jiu* '9' × *qian* '1000'] and [*liu* '6' × *shi* '10']. In the [Num C/M N] sequence, [Num C/M] can likewise be viewed as a [$n \times base$], or [*multiplier* × *multiplicand*], operation, a natural extension of the number system (Au Yeung 2005, 2007, Her to appear). In (7), therefore, the C's all have precisely the same mathematical value, *1*, though each characterizing a unique semantic aspect of the noun.

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[1] A reviewer pointed out that while C is mathematically redundant, it may not be so syntactically or semantically, because C may be strictly required in certain contexts, e.g. **jibai yu* 'several-hundred fish' in Mandarin. However, note that *jibai* (*ge*) *ren* 'several-hundred persons' is perfectly acceptable. Also, in many classifier languages, C is optional. Among the 140 classifier languages reported in Gil (2011), a whopping 62 allow numeral classifiers to be optional.

[2] Using *san da meiguihua* or *three dozen roses* as an example, in the equation $3 \times 12 = 36$, 12 is the multiplicand, representing the number in a group, and 3 is the multiplier, referring to the number of groups.

(7) a. 三 位 老師
san *wei* *laoshi* ([3 × *1*] teacher)
three C teacher
'three teachers'

b. 七 隻 老虎
qi *zhi* *laohu* ([7 × *1*] tiger)
seven C tiger
'seven tigers'

c. 十 顆 西瓜
shi *ke* *xigua* ([10 × *1*] watermelon)
ten C watermelon
'ten watermelons'

d. 八 輛 汽車
ba *liang* *qiche* ([8 × *1*] car)
eight C car
'eight cars'

M's value, on the other hand, is anything but *1*, thus ¬*1*. The possibilities of an M's value are thus infinite, and the actual value can be numerical or non-numerical. In the case of it being numerical, it can denote a specific number, e.g. (8a-b), or it can designate an unspecified number, e.g. (9a-b).

(8) a. 兩 打 玫瑰
liang *da* *meigui* ([2 × *dozen*(=*12*)] rose)
two M-dozen rose
'two dozen roses'

b. 三 雙 鞋
san *shuang* *xie* ([3 × *pair*(=*2*)] shoe)
three M-pair shoe
'three pairs of shoes'

(9) a. 一 群 野馬
yi *qun* *yema* ([1 × *herd*(n=?)] wild-horse)
one M-herd wild-horse
'one herd of wild horses'

b. 三 組 學生
san *zu* *xuesheng* ([3 × *group*(n=?)] student)
three M-group student
'three groups of students'

The actual value of an M can also be non-numerical, which can in turn be of a predetermined fixed value, such as standard measures, e.g. (10a-b), or it can be a non-determined variable value, e.g. (11a-b).

(10) a. 四 公斤 鹽
si *gongjin* *yan* ([4 × *kilo*] salt)
four M-kilo salt
'four kilos of salt'

b. 三 碼 布
san *ma* *bu* ([3 × *yard*] fabric)
three M-yard fabric
'three yards of fabric'

(11) a. 四 箱 鹽
si *xiang* *yan* ([4 × *box*] salt)
four M-box salt
'four boxes of salt'

b. 三 堆 布
san *dui* *bu* ([3 × *pile*] fabric)
three M-pile fabric
'three piles of fabric'

This mathematical distinction of *1* versus ¬*1* between C/M reflects M's 'opacity' and C's 'transparency' (see §2.2), as the multiplicand is vacuous when it has precisely the value of *1*, but it is substantive otherwise. C/M thus share this important common property, i.e. being the multiplicand, and yet differ crucially in their values. This is why C/M share some common behaviors but also differ in significant ways.

Finally, though C/M share the cognitive function as a divider (Borer 2005) or parceler (Landman 2004) for the noun, C uniquely serves the function as a profiler, in the sense of Fillmore (1982) and Langacker (1987), and highlights a certain inherent semantic feature of the noun (Hsieh 2009, Her & Lai to appear, Her & Hsieh 2011). Take (12) for example.

(12) 一 把 壺
yi *ba* *hu*
one C(handle) teapot
'one teapot'

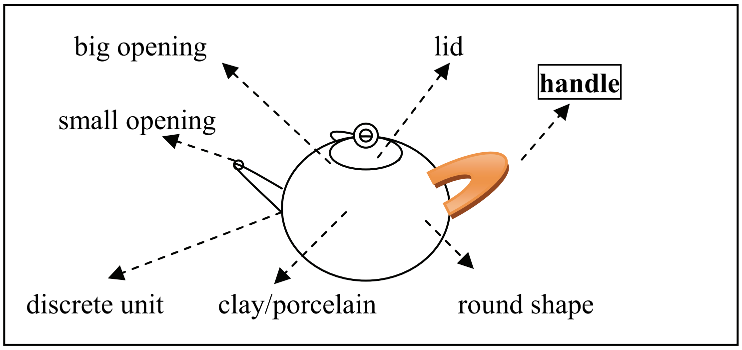


Figure 1: N as Frame and C as Profile

Figure 1 shows schematically that N *pot* provides the frame, where having a handle is an inherent feature, which is profiled by C *ba*.[3] This view explains why C, as a mathematically vacuous element, is needed for a cognitively-motivated linguistic function. The many C's in a classifier language thus represent the many ways to profile the multiplicand *1* in the language (Greenberg 1990a:172, Her & Lai to appear). Since a C can only profile a feature that the noun inherently possesses, this view also explains quite naturally why each C selects its class of nouns. Different languages can thus have different ways to profile this multiplicand *1*, and therefore different ways to classify nouns. In fact, within the same language, the same noun may have more than one profilable feature. For example, *teapot* can also co-occur with the general classifier *ge*, as in *yi ge hu* (1 C teapot). In the case of a general classifier, it profiles the discreteness of the entity and thus selects nouns that are countable.

2.2 C/M's differences in behavior

This subsection first illustrates the different behaviors that C/M display, which, as revealed by Her & Hsieh (2010) and Her (to appear), is due to the semantic distinction between C/M in [Num C/M N], where C is redundant and M substantive.

[3] A reviewer pointed out that this analysis fails to account for *ba* in such examples as 一把鼻涕、一把眼淚 *yi ba biti*, *yi ba yanlei* (one handful nasal-mucus, one handful tear) 'a handful of nasal-mucus and a handful of tears', indicating some serious crying and sobbing. Note, however, as noted by many researchers (e.g. Her & Lai to appear), certain lexemes may function as a C and an M, *ba* being a good example. The two instances above involve *ba* as an M, meaning *handful*, not a C profiling the *handle*. The reviewer is correct, nonetheless, in suggesting that both cases should find origin in the verbal meaning of *hold* in Archaic Chinese.

First of all, C/M differ crucially in several scope phenomena, as first observed in Her & Hsieh (2010), H&H hereafter, and Zhang (2011). The first observation relates to the scope of adjectival modification. Though the bare adjectives allowed on C/M are rather restricted to size and length, when allowed, the adjective scopes over C as well as N, but modifies M only. This contrast is shown in (13).[4]

(13) a. 一 大 箱 蘋果 ≠ 一 箱 大 蘋果 (H&H 13a)
yi ***da*** *xiang pingguo* *yi xiang* ***da*** *pingguo*
one big M-box apple one M-box big apple
'one big box of apples' 'one box of big apples'

b. 一 大 顆 蘋果 = 一 顆 大 蘋果 (H&H 13b)
yi ***da*** *ke pingguo* *yi ke* ***da*** *pingguo*
one big C apple one C big apple
'one big apple' 'one big apple'

Consequent of this scope phenomenon, a C modifier and an N modifier must be compatible, as shown in (14), while an M modifier and an N modifier can be contradictory, as shown in (15).

(14) a. #一 大 顆 小 蘋果 (H&H 15a)
yi da C ***xiao*** *pingguo*
one big C small apple

b. #大大的 一 顆 小 蘋果 (H&H 15b)
dadade *yi ke* ***xiao*** *pingguo*
big one C small apple

c. #大大的 一 顆 小小的 蘋果
dadade *yi ke* ***xiaoxiaode*** *pingguo*
big one C small apple

(15) a. 一 大 箱 小 蘋果 (H&H 14a)
yi ***da*** *xiang* ***xiao*** *pingguo*
one big M-box small apple
'one big box of small apples'

[4] A reviewer questioned why 一手冰啤酒 *yi shou bing pijiu* (1 six cold beer) 'a six-pack of cold beer' is good but *一冰手啤酒 *yi bing shou pijiu* (1 cold six beer) is bad. First of all, here 手 *shou* has the precise value of 6, similar to the value of 2 of 雙 *shuang* 'pair' and 12 of 打 *da* 'dozen'. All three are thus M. As pointed out by many researchers (e.g. H&H, Zhang 2011), the adjectives allowed to modify C/M are highly restricted, usually to the ones related to size or length.

b.	大大的	一	箱	小	蘋果	(H&H 14b)
	dadade	*yi*	*xiang*	***xiao***	*pingguo*	
	big	one	M-box	small	apple	
	'one big box of small apples'					
c.	大大的	一	箱	小小的	蘋果	
	dadade	*yi*	*xiang*	***xiaoxiaode***	*pingguo*	
	big	one	M-box	small	apple	
	'one big box of small apples'					

In (15), all three phrases are semantically congruent, as the box is big and the apples are small. Yet, (14) differs in having a C and all three phrases are incongruent, as the apples cannot be big and small at the same time. Note that Zhang (2011) makes the same observation independently. In addition, Her (to appear) has discovered several other syntactic contexts where this very difference in adjectival scope between C/M is displayed. For our purpose in this paper, it is quite sufficient to have demonstrated this difference in one of the environments.

The other type of scope phenomena relates to Num's scope of quantification. This scope goes beyond C and includes N, referring to the cardinality of a set of N. Yet, Num does not scope over N if followed by an M and thus quantifies M only. This is demonstrated by the fact that C, in an appropriate context, can be omitted, but not M. Thus, the Biblical story of Jesus' performing a miracle with 'five loaves of bread and two fishes' is preferably referred to as (16), whose meaning is identical to (17), where the missing C's are all overtly filled. Again, the omission of C is possible because it is semantically redundant as a profiler and mathematically null as the multiplicand *1*.

(16)	五	餅	二	魚	餵飽	五千	人
	wu	*bing*	*er*	*yu*	*weibao*	*wuqian*	*ren*
	five	loaf	two	fish	feed-full	five thousand	person
	'Five thousand people were fed with five loaves and two fish.'						

(17)	五	**張**	餅	二	**條**	魚	餵飽	五千	**個**	人
	wu	***zhang***	*bing*	*er*	***tiao***	*yu*	*weibao*	*wuqian*	***ge***	*ren*
	five	**C**	loaf	two	**C**	fish	feed-full	five thousand	**C**	person
	'Five thousand people were fed with five loaves and two fish.'									

To summarize, C/M differ only in terms of scope phenomena. Metaphorically, C is *transparent* in that numerals and pre-C adjectives scope over C as well as N; M is *opaque* and numerals and pre-M adjectives only scope over M, not N. H&H attribute this difference to C's being semantically redundant and M substantive in [Num C/M N].

Her (to appear) further attributes this transparent property of C to the fact that, as the multiplicand of Num, C has the precise value of *1* and is thus vacuous and optional. M, on the other hand, has a value other than *1* and therefore cannot be omitted. We shall see in section 3 that C/M otherwise behave quite similarly.

3. C/M similarities

Other than the differences documented above, C/M behave the same and share at least seven common properties.

3.1 C/M are mutually exclusive

The first observation is rather obvious, i.e. C/M occupy the same position in [Num C/M N], and, as shown in (18), are mutually exclusive.

(18)	a.	*一	箱	本	書
		yi	*xiang*	*ben*	*shu*
		one	M-box	C	book
	b.	*一	本	箱	書
		yi	*ben*	*xiang*	*shu*
		one	C	M-box	book

This suggests that C/M belong to the same category. However, one might suggest that C/M's mutual exclusivity is due to semantic incompatibility. For example, in Krifka's (1995, 2003) system, the difference between English and Chinese is that in English a numeral combines directly with N, which in effect has a 'built-in' C, reflected via plural inflection. In Chinese, the combination of a C/M with N requires a numeral as its sister for the sake of compositional semantics. Thus, (18) can be ruled out on the ground that a C/M is not combined with a numeral. This theory thus dictates that a numeral combine with an overt C/M or with an N marked for plural morphology. Yet, there are attested languages with no C's, nor plurality marking, e.g. the Athapaskan language Dene Suline in central Canada (Wilhelm 2008) and Archaic Chinese (e.g. Norman 1988:120). Also, as seen in the example of (16) in §2.2, C is in fact not strictly required in Modern Chinese. Furthermore, as we shall see momentarily in this section, another C/M common property is that Num can also be elided in Chinese, thus [~~Num~~ C/M N], when its value is precisely *1*. Thus, C/M's mutual exclusivity cannot be attributed to semantic incompatibility.

To demonstrate that C and M are semantically compatible, we first need to point out again the same multiplication operation in high round numbers, e.g. 三百 *sanbai*

‘300’ involes [*n* × *base*], where *3* is the multiplier and *bai* ‘hundred’ the multiplicand, and the [Num C/M] sequence, which can likewise be viewed as a [*n* × *base*], or [*multiplier* × *multiplicand*], operation. This simple math in C/M is seen in (19a-b).

(19)	a.	三	朵	玫瑰		
		san	*duo*	*meigui*		(3 ×**1** rose)
		three	C	rose		
		‘three roses’				
	b.	三	打	玫瑰		
		san	*da*	*meigui*		(3×**12** rose)
		three	M-dozen	rose		
		‘three dozen roses’				
(20)	a.	三百	朵	玫瑰		
		san-bai	*duo*	*meigui*		(300 ×**1** rose, or 3 ×**100 × 1** rose)
		three hundred	C	rose		
		‘three hundred roses’				
	b.	*三	打	朵	玫瑰	
		san	*da*	*duo*	*meigui*	(3 ×**12 × 1** rose)
		three	M-dozen	C	rose	
		(Intended) ‘three dozen roses’				

Note, however, in (20a), there are two ways to conceive the multiplication relation, that is, 三百 *sanbai* ‘300’ can be seen either as a single number or as a [3 × *bai*] sequence. This latter interpretation has the same semantic and mathematic structure as that of (20b), where the only difference is the replacement of *bai* ‘hundred’ with *da* ‘dozen’. And yet, (20a) is good, which yields the interpretation *300 roses* or *3 sets of 100 roses*, but (20b) is bad, which yields the interpretation *3 sets of 12 roses* or *36 roses*. Given that both *bai* ‘hundred’ with *da* ‘dozen’ are similar semantically and mathematically in that they both denote a precise numerical value, the ill-formedness of (20b) can thus only be attributed to the fact that *bai* ‘hundred’ belongs to the category Num, *da* ‘dozen’ the category C/M. This restriction against C/M appearing in the same slot is therefore purely formal. C/M are thus of the same syntactic category.

3.2 Both C/M allow N ellipsis

Second, C/M are identical in allowing N ellipsis, thus [Num C/M ~~N~~], when N is recoverable from discourse. We shall discuss this construction in more detail in §5.

(21) a.

他	有	三	箱	書，	我	有	三	本
ta	*you*	*san*	*xiang*	*shu*	*wo*	*you*	*san*	*ben*
he	have	three	M-box	book	I	have	three	C

‘He has three boxes of books, I have three (books).’

b.

他	有	三	本	書，	我	有	三	箱
ta	*you*	*san*	*ben*	*shu*	*wo*	*you*	*san*	*xiang*
he	have	three	C	book	I	have	three	M-box

‘He has three books, I have three boxes (of books).’

3.3 Both C/M allow ellipsis

Third, C/M are also identical in allowing themselves to be elided, thus [Num ~~C/M~~ ~~N~~], as long as N and C/M are both recoverable from discourse and Num is a high number round figure.

(22) a.

他	有	一百	本	書，	我	有	三百
ta	*you*	*yibai*	*ben*	*shu*	*wo*	*you*	***sanbai***
he	have	one hundred	C	book	I	have	**three hundred**

‘He has one hundred books, I have three hundred.’

b.

*他	有	一百	本	書，	我	有	三
ta	*you*	*yibai*	*ben*	*shu*	*wo*	*you*	***san***
he	have	one hundred	C	book	I	have	**three**

‘He has one hundred books, I have three.’

(23) a.

他	有	一百	箱	書，	我	有	三百
ta	*you*	*yibai*	*xiang*	*shu*	*wo*	*you*	***sanbai***
he	have	one hundred	M-box	book	I	have	**three hundred**

‘He has one hundred boxes of books, I have three hundred (boxes of books).’

b.

*他	有	一百	箱	書，	我	有	三
ta	*you*	*yibai*	*xiang*	*shu*	*wo*	*you*	***san***
he	have	one hundred	M-box	book	I	have	**three**

‘He has one hundred boxes of books, I have three (boxes of books).’

In a corpus-based study by Paris & Vinet (2010), the approximative 左右 *zuoyou* ‘around, about’ also prefers to follow larger round figures. Indeed, the acceptability of the well-formed examples in (22)-(23) can be further increased with *zuoyou* added at the end. However, the ill-formed examples cannot be rescued at all. The identical underlying multiplication in high number round figures and [Num C/M] provides a logical explanation. 三百 *sanbai* '300', for example, involves [*3* × *bai*], where *bai* serves as the base, or multiplicand; likewise, 三百本 *sanbai ben* '300 C' and 三百箱 *sanbai xiang* '300 boxes' involve [*300* × *ben*/*xiang*], where *ben* and *xiang* also serve as the base, or multiplicand. Thus, a discoursally recoverable C/M can be elided as long as the remaining Num itself is analyzable as the [*n* × *base*] structure, thus resembling the [Num C/M] structure. A more clear illustration of this parallel structure between the base in a high number round figure and the C/M in [Num C/M] in given in (24). In (24a), only Num 三百 *sanbai* '300' remains, with C/M and N elided, while in (24b), only N is elided, and Num and C/M remain. What makes the remaining Num 三百 *sanbai* '300' in (24a) acceptable is its internal structure of [*3* × *bai*], which resembles the structure of [*3* × *da*] in (24b).

(24)	a.	他	有	一百	朵	玫瑰，	我	有	三百	
		ta	*you*	*yibai*	*duo*	*meigui*	*wo*	*you*	***sanbai***	
		he	have	one hundred	C	rose	I	have	**three hundred**	
		'He has one hundred roses, I have three hundred.'								
	b.	他	有	一百	朵	玫瑰，	我	有	三	打
		ta	*you*	*yibai*	*duo*	*meigui*	*wo*	*you*	***san***	***da***
		he	have	one hundred	C	rose	I	have	**three**	**dozen**
		'He has one hundred roses, I have three dozen.'								

3.4 Both C/M allow *-de* insertion

Fourth, C/M are alike in allowing -*de* to intervene, and thus [Num C/M-*de* N] is well-formed. Previously, it has been repeatedly claimed that *de* may be optionally inserted after M but not C (e.g. Chao 1968:555, Paris 1981:32, Zhu 1982:51, Tai & Wang 1990, Tai 1994, Cheng & Sybesma 1998:388, 1999:515). Cheng & Sybesma (1998, 1999) further argue that this distinction is related to the count/mass distinction, and thus the distinction between partitives versus pseudo-partitives (e.g. Selkirk 1977, Jackendoff 1977). Specifically, M allows -*de* because it refers to an amount of some substance, expressed thus by a mass noun, while C disallows -*de* because it refers to a part or subset of a superset, which can be expressed only by a count noun. However, as noted by Tang (2005), Hsieh (2008), Li (2011), Li & Rothstein (2012), and Zhang (2011), and also demonstrated most convincingly by H&H, C/M differ little in this regard.[5] This fact varies little among dialects within Mandarin Chinese, as some of the

[5] Li (2011) and Li & Rothstein (2012), observing that C/M both allow -*de* but C requires a high number round figure or an approximative, attributes the counting versus measuring function, thus the partitive versus pseudo-partitive distinction, to two different structures of [Num C/M

above dissenting researchers are from China, and the others from Taiwan. The two examples in (25) are from the Sinica Corpus, cited in Hsieh (2008).

(25) a.

五百萬	隻	的	鴨子
wubaiwan	***zhi***	***de***	*yazi*
five-million	C	DE	duck

‘five million ducks’

b.

幾百	條	的	海蛇
jibai	***tiao***	***de***	*haishe*
several-hundred	C	DE	sea-snake

‘some hundreds of sea snakes’

Examples in (26) and (27) are all from Google searches within the Taiwan domain (.tw), cited in H&H; 70 instances of 之一顆的 *zhiyi ke de* ‘one fraction of’ were found, two of which are listed in (26). The two examples in (27) gave 13 and 9 exact matches, respectively.

(26) a.

八分之一	顆	的	高麗菜
bafenzhiyi	*ke*	*de*	*gaolicai*
one-eighth	C	DE	cabbage

‘one-eighth cabbage’

b.

四分之一	顆	的	洋蔥
sifenzhiyi	*ke*	*de*	*yangcong*
one-fourth	C	DE	onion

‘one-fourth onion’

(27) a.

一	大	顆	的	高麗菜
yi	*da*	*ke*	*de*	*gaolicai*
one	big	C	DE	cabbage

‘one big cabbage’

b.

一	大	條	的	魚
yi	*da*	*tiao*	*de*	*yu*
one	big	C	DE	fish

‘one big fish’

Num], the former right-branching, and the latter left-branching, thus a split analysis. However, H&H demonstrate that it is the computational complexity of the Num or the N that affects the acceptability of C-*de* (i.e. the more complex, the more acceptable C-*de*) and instead attributes this property to the conceptual closeness between C and N. Section 5 of this paper argues against the right-branching structure, and thus also against the split analysis.

H&H thus observe a close correlation between the acceptability of *-de* insertion and the computational complexity of Num and/or C, as shown in the examples of (26)-(27), a factor more related to processing than to grammar itself, and further claim that other than this, there is little difference between C/M in terms of *-de* insertion.

3.5 Both C/M allow Num ellipsis, if Num = 1

Fifth, interestingly, Num can also be elided, thus [~~Num~~ C/M N], when its value is precisely *1*. Again, C/M behave the same. This makes perfect sense mathematically, as $(n \times m) = m$, *if* $n = 1$. The multiplier *1* can thus be omitted. Again, C/M behave the same in this regard. This property is similar to the omission of C, as the underlying multiplication in [Num C] is $[n \times 1]$, where the multiplicand *1* can be omitted.[6]

(28) a. 這 (一) 本/箱 書
zhe (*yi*) *ben*/*xiang* *shu*
the one C/M-box book
'This one book/box of books'

b. 他 買了 (一) 本/箱 書
ta *mai-le* (*yi*) *ben*/*xiang* *shu*
he buy-ASP one C/M-box book
'He bought one book/box of books.'

3.6 In [Num C/M N], N is the head

The sixth common property is that N is the head in [Num C/M N]. C/M do not differ. One indication comes from selectional restrictions imposed by the verb.

(29) a. 這 三 條/尾 魚 都 還 活著， 你 想 養 嗎？
zhe san tiao/*wei yu dou hai huozhe ni xiang yang ma*
the three C/C fish all still alive-ASP you want raise Q
'The three fish are all still alive, so do you want to raise them?'

b. 這 三 公斤/箱 魚 都 還 活著， 你 想 養 嗎？
zhe san gongjin/*xiang yu dou hai huozhe ni xiang yang ma*
the three kilo/M-box fish all still alive-ASP you want raise Q
'The three kilos/boxes of fish are all still alive, so do you want to raise them?'

6 According to Cheng & Sybesma (2005), besides Mandarin, Cantonese and Wu also allow bare [C/M N] phrases, but Min does not.

In (29a) and (29b) alike, *fish* is an appropriate subject for the predicate *alive* and likewise an appropriate object for the verb *raise*. C/M thus make no difference in having N as the head of the nominal phrase.

3.7 Both C/M allow *ban* 'half' and *duo* 'more' to follow

The seventh property is that C/M both allow *ban* 'half' and *duo* 'more' to follow. Pay close attention to the meaning of (30a) and (30b). In the preferred reading of (30a), *ban* 'half' is interpreted in reference to the preceding C *ge*, not the following *xiaoshi* 'hour'; hence, the total time is not [*2 × 1/2 hour*], but rather [[*2 × 1* (*hour*)] + *1/2hour*]. Likewise, in (30b), *duo* 'more' is interpreted in reference to the preceding M *da* 'dozen', not the following *meigui* 'rose'; hence, the total roses are more than six dozens but less than seven dozens. This construction thus reveals that [Num C/M *ban/duo*] together as a constituent function as the quantifier (Hsieh 2008:45-46).

(30) a. 兩 個 半 小時
liang ge ban xiaoshi
two C half hour
'two and half hours'

b. 六 打 多 玫瑰
liu da duo meigui
six M-dozen more rose
'six dozens of roses and more'

To summarize the discussions in §3, other than the scope phenomena described in §2.2, C/M behave the same: they occupy the same position in [Num C/M N], where N is the head, and allow the same ellipsis, *-de* insertion, and *ban* 'half' and *duo* 'more' to follow. As we shall see in §4, these similarities are instrumental to the correct syntactic configuration of the [Num C/M N] phrase.

4. Previous syntactic analyses

There are two crucial aspects in the syntactic analysis of [Num C/M N]. The first is whether C/M form a constituent with Num or N first; the former projects a left-branching structure and the latter a right-branching structure. The second aspect is whether C/M share the same left- or right-branching structure. Thus, in this paper we shall largely ignore the intricate details in the analyses previously proposed and will focus on the directions of branching of the structures and whether C/M share the same direction of branching. Therefore, if an account has C/M generated in two different positions but with the same direction of branching, it is taken to be a unified account. A split account is one that assigns C/M two branching directions.

Given the fact that C/M behave similarly and differently at the same time, there is little wonder that there is no consensus in the literature as to the correct syntactic configuration of the [Num C/M N] phrase. A bias towards the similarities naturally leads to a unified analysis, and otherwise a split analysis. §4.1 presents the unified approach and critically examines its pros and cons, and §4.2 does the same with the split analysis. An LFG alternative is proposed in §5.

4.1 Unified Analyses

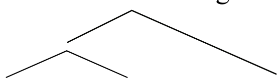
Again, details aside, an account that assigns C/M the same direction of branching is considered a unified account here. Whether it is unified left- or right-branching, each has its advantages and disadvantages.

Unified left-branching

The unified left-branching account, where the numeral and C/M form an exclusive constituent, as shown schematically in (31), enjoys a long history, one that has the early support by Greenberg in his seminal work (1990b).

> There are many indications that in the tripartite construction consisting of quantifier (Q), classifier (Cl), and head noun (N), *Q is in direct construction with Cl* and this complex construction, which will be called the classifier phrase, is in turn in construction with N. (Greenberg 1990b:227, *emphasis added*)

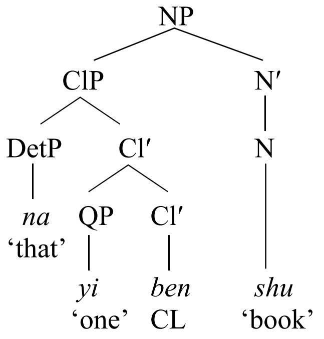
(31) Unified left-branching structure



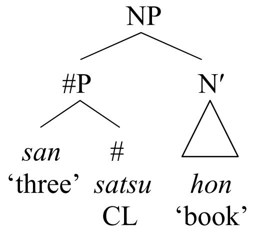
Num	C/M	N
san	*ben/xiang*	*shu*
three	C/M-box	book

Over the decades, this account has been widely accepted, e.g. Li & Thompson (1981:105), Paris (1981:105-117), Huang (1982), Tang (1990), Croft (1994:151), Lin (1997:419), and Hsieh (2008). In his seminal work on Chinese phrase structure, Huang (1982) posits (32) as a unified analysis for C/M. Fukui & Takano (2000) also propose a similar structure for Japanese C/M, shown in (33).

(32) Huang's (1982) unified left-branching account for Chinese



(33) Fukui & Takano's (2000) unified left-branching account for Japanese

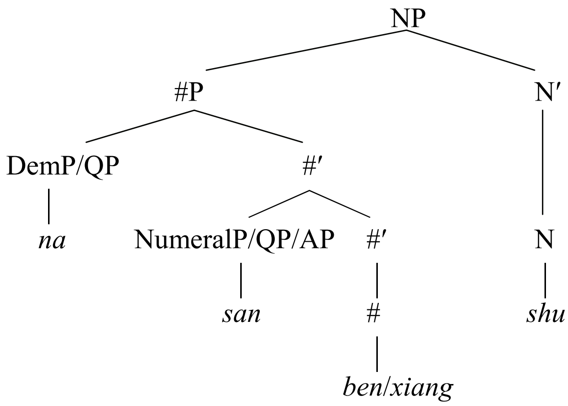


The most recent endorsement for the unified left-branching account is from Hsieh (2008), in her book dedicated to the study of the Chinese NP. In (34), an example is given to illustrate Hsieh's (2008) unified account.

(34) 那 三 本/箱 書

na *san* *ben*/*xiang* *shu*

that three C/M-box book

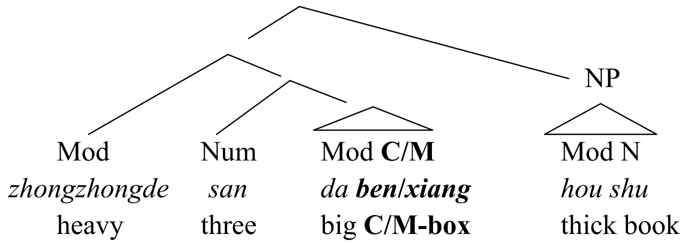


All unified accounts enjoy the obvious advantage that all the common properties documented in detail in §3 that C/M share only need to be stated once. Yet, a unified left-branching account, in particular, has the advantage over the right-branching counterpart in that it captures the parallel mathematical structure, i.e. [*n* × *base*], between the constituent of a high number round figure Num and the constituent of [Num C/M]. However, as Zhang (2011) aptly points out, this account generalizes that all pre-C/M modifiers and Num scope over C/M only, not N, as shown in (35).

(35) Unified left-branching structure

a. 重重的 三 大 本 厚 書
zhongzhongde san da ben hou shu
heavy three big C thick book
'three heavy big thick books'

b. 重重的 三 大 箱 厚 書
zhongzhongde san da xiang hou shu
heavy three big M-box thick book
'three heavy big boxes of thick books'

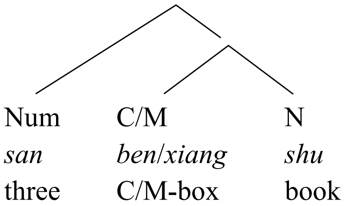


As seen in §2.2, pre-C adjectives and Num must scope over C as well as N. Yet, in (35), the modifiers *heavy* and *big* do not c-command N and thus cannot scope over N. Likewise, Num also does not c-command NP and thus also does not scope over N.

Unified right-branching

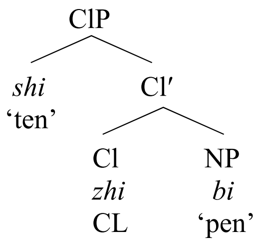
On the flip side, many of the more recent formalist studies on this subject favor a unified right-branching analysis, as shown schematically in (36), e.g. Tang (1990:413, 2005), Cheng & Sybesma (1998, 1999), Borer (2005), Watanabe (2006), Zhang (2009), among others.

(36) Unified right-branching structure

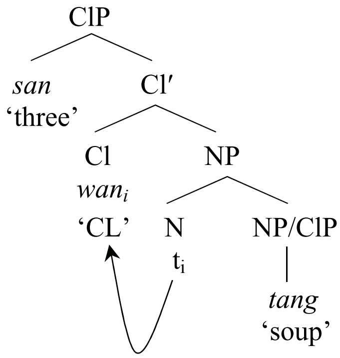


Cheng & Sybesma (1998, 1999), for example, propose that C is base-generated as the head of ClP, as in (37a), while M, as shown in (37b), only moves to C from its original lower position. Movement put aside, both C/M form a constituent with N first, excluding Num.

(37) a. 十 枝 筆
shi *zhi* *bi*
ten C pen

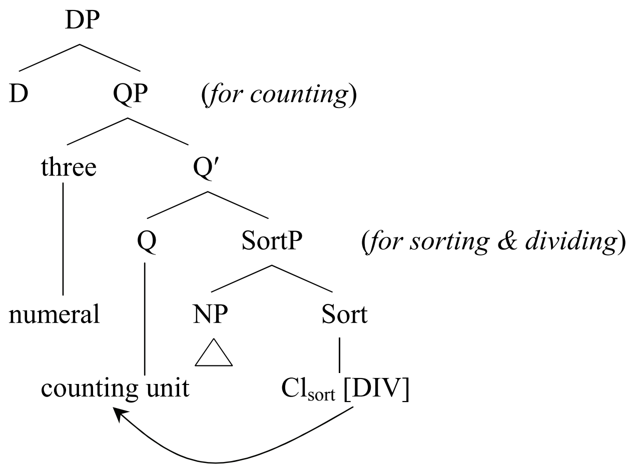


b. 三 碗 湯
san *wan* *tang*
three M-bowl soup



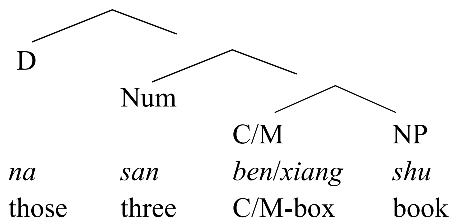
Zhang (2009), on the other hand, contends that C is base-generated as the head of a SortP, with a preceding NP as its complement, and moves up to Q, where M is base-generated. This account is shown in (38). Again, details aside, both C/M form a constituent with N first, excluding Num.

(38)



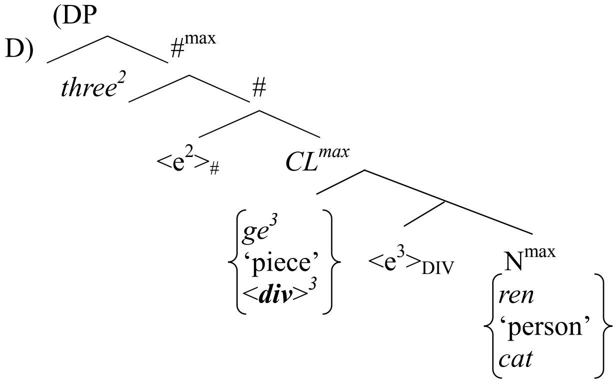
Tang (2005), in contrast, has both C and M straightforwardly base-generated as the head of ClP, or classifier phrase, with no movement involved.

(39)

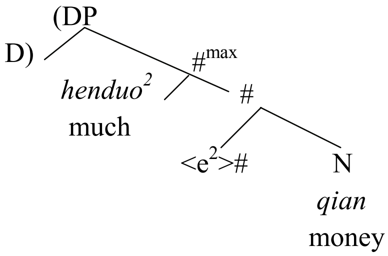


Borer (2005) proposes that Chinese C parallels English plurality marker *-s* and functions as a mass *divider* that affords the noun a count interpretation in the structure in (40a). M, on the other hand, parallels English measure phrases and has the structure in (40b), possibly as the head of $\#^{max}$.

(40) a.



b.



In spite of Borer's (2005) claim that lexically all nouns in all languages are mass by default and the two different structures assigned to C/M, C/M behave the same in forming a constituent with N first, excluding Num. Like the unified left-branching accounts, these unified right-branching accounts have the advantage that all the common properties documented in detail in §3 that C/M share only need to be stated once. However, like the unified left-branching account, the unified right-branching account also generalizes the scope of a pre-C/M adjective and the quantification scope of Num (Zhang 2011).

(41) Unified right-branching structure

a.

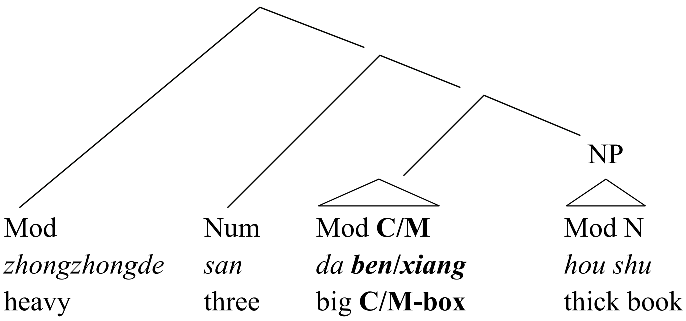
重重的	三	大	本	厚	書
zhongzhongde	*san*	*da*	*ben*	*hou*	*shu*
heavy	three	big	C	thick	book

'three heavy big thick books'

b.

重重的	三	大	箱	厚	書
zhongzhongde	*san*	*da*	*xiang*	*hou*	*shu*
heavy	three	big	M-box	thick	book

'three heavy big boxes of thick books'



The structure in (41) shows that all pre-C/M modifiers and Num c-command C/M as well as N and thus scope over C/M as well as N, if C/M are assumed to be functional. Yet, if C/M are assumed to be lexical, then pre-C/M modifiers and Num only scope over C/M, but not N. This is a dilemma given that, as seen in §2.2, pre-M numerals and pre-M adjectives scope over M, but not N.

Zhang (2011) thus also rejects the right-branching account, which treats C/M uniformly. Yet, a possible solution to this dilemma is found in Vos (1999) and van Riemsdijk (1998), where it is assumed that M is lexical and thus opaque blocking modification and quantification to scope over N, while C is semi-lexical, thus more functional than purely lexical items such as M, and is therefore transparent. This is similar to Kubo's (1996) proposal to distinguish syntactic, semantic, and cognitive elements in grammar, and to view M as semantic and C as cognitive. Her & Hsieh (2010) likewise point out that C is a closed set and M an open set in Chinese, corresponding to a functional category and a lexical category respectively. Note that in the left-branching structure of (35), C, being semi-lexical and thus transparent, still does not allow the non-c-commanding adjectives and Num to scope over N. The right-branching account, therefore, fares better than the left-branching counterpart in relation to C/M differences in scope phenomena. However, in §5.1 we shall see that the left-branching account fares better in capturing C/M's common behaviors and that there are also other good reasons from word order typology to reject the right-branching account. An ultimate LFG solution is then offered in §5.2, which also takes advantage of the insight that C is less lexical and more functional than M.

4.2 A split analysis

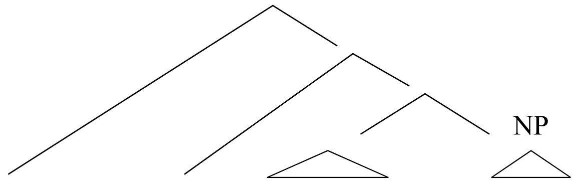
Having considered the advantages and disadvantages of the unified accounts, Zhang (2011) concludes that a split analysis is the best solution, where C appears in a right-branching structure, as in (42a), and M a left-branching structure, as in (42b).

(42) Split Analysis (Zhang 1011)

a. Right-branching for C

重重的	三	大	本	厚	書
zhongzhongde	*san*	*da*	*ben*	*hou*	*shu*
heavy	three	big	C	thick	book

'three heavy big thick books'

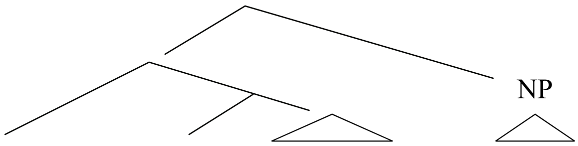


Mod	Num	Mod	**C**	Mod N
zhongzhongde	*san*	*da*	***ben***	*hou shu*
heavy	three	big	**C**	thick book

b. Left-branching for M

重重的	三	大	箱	厚	書
zhongzhongde	*san*	*da*	*xiang*	*hou*	*shu*
heavy	three	big	M-box	thick	book

'three heavy big boxes of thick books'



Mod	Num	Mod	**M**	Mod N
zhongzhongde	*san*	*da*	***xiang***	*hou shu*
heavy	three	big	**M-box**	thick book

The obvious advantage of the split analysis is that it nicely captures how C and M differ in scope phenomena. On the other hand, its biggest disadvantage is precisely that it is a split analysis. A unified account is simpler and is thus always preferred, everything else being equal.

Out of the seven properties that C/M share, the first property documented in §3 is that C/M seem to be mutually exclusive and thus seem to occupy the same position. (42a) and (42b) fail to capture this.

The second property is that N can be elided in [Num C/M N]. Amongst the studies that propose a right-branching analysis for C, it is assumed that the classifier heads its own projection (Saito et al. 2008); thus, in (42a), the elided NP is the complement of C. Yet, in (42b), N is the head of the entire phrase. A generalization cannot be made.

The third property is C/M and N can both be elided if Num is a high number and a round figure, e.g. 100 or 300. Again, C/M in (42a) and (42b) respectively do not enter a uniform relation with N and thus a single generalization likewise cannot be made of how C/M can both be elided together with N.

The fourth property is that C/M are alike in allowing -*de*, thus [Num C/M-*de* N]. Again, C/M do not enter the same relation with N and thus a single generalization cannot be made.

The fifth property is that C/M behave similarly in allowing Num to be optional if Num is *one*. Since in both (42a) and (42b) Num c-commands C and M, a single generalization can be made.

The sixth property is that, in terms of selectional restrictions imposed by a verb on the phrase [Num C/M N], N is the head regardless of the preceding C/M. Yet, while in (42b), N is the head; in (42a) C is the head, not N, which is C's complement.

Finally, the seventh property, that both C/M allow *ban* 'half' and *duo* 'more' to follow, also cannot be generalized across C/M in the split analysis.

Fundamentally, the split analysis fails to capture the uniform mathematical structure between Num and C/M, i.e. multiplier and multiplicand, an insight reflected only by (42b), not (42a). In §5, we shall indeed argue for a uniform c-structure, or constituent structure, based on the left-branching (42b).

5. An LFG account

With the three possible accounts more or less rejected, the focus in this section is a solution to the syntactic structure of [Num C/M N] within the Lexical Functional Grammar (LFG) (cf. Bresnan 2001, Falk 2001). An essential theoretic assumption of LFG is that the semantic argument structure (a-structure), the relational structure of grammatical functions (or f-structure), and the configurational structure of phrasal constituents (c-structure), are all parallel autonomous planes of grammatical organization related by local structural correspondences, in the same way that the melody of a song relates to its lyrics (e.g. Bresnan & Kanerva 1989). In §5.1, a unified c-structure will be proposed to account for C/M similarities and a split f-structure analysis is proposed in §5.2 due to C/M differences.

5.1 A unified left-branching c-structure

The left-branching c-structure, repeated as (43), is favored over its right-branching counterpart because it captures the uniform underlying [*multiplier* × *multiplicand*] mathematical structure between high number round figures and C/M. Yet, the right-branching account has the advantage of capturing the C/M differences in scope phenomena, where C is assumed to be semi-lexical and thus more functional and transparent. Therefore, if we are able to explain the scope differences within the left-branching structure, then it should be favored.

(43) Unified left-branching c-structure

a.

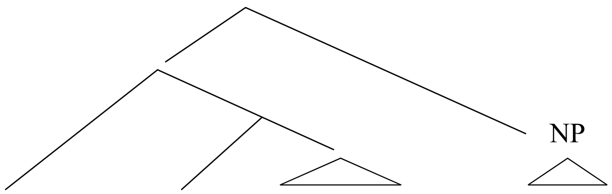
重重的	三	大	本	厚	書
zhongzhongde	*san*	*da*	*ben*	*hou*	*shu*
heavy	three	big	C	thick	book

‘three heavy big thick books’

b.

重重的	三	大	箱	厚	書
zhongzhongde	*san*	*da*	*xiang*	*hou*	*shu*
heavy	three	big	M-box	thick	book

‘three heavy big boxes of thick books’



Mod	Num	Mod	**C/M**	Mod N
zhongzhongde	*san*	*da*	***ben/xiang***	*hou shu*
heavy	three	big	**C/M-box**	thick book

The unified left-branching c-structure better captures C/M’s seven common properties in the phrase [Num C/M N]: (1) C/M are mutually exclusive, (2) N can be elided, (3) C/M can also be elided along with N, if Num is a high number and a round figure, (4) C/M both allow *-de*, (5) Num is optional if its equals *one*, (6) N is the head, and (7) both C/M allow *ban* ‘half’ and *duo* ‘more’ to follow. We shall now see a point-by-point comparison with the right-branching option.

Property (1), C/M being mutually exclusive, does not favor either left or right. Yet, an explanation is needed for property (2), N ellipsis. As mentioned earlier, among unified right-branching analyses, it is universally assumed that the classifier heads its own projection and thus the elided NP is the complement of C (Saito et al. 2008). Indeed, the major cases of N′-ellipsis, VP-ellipsis, and sluicing all involve functional heads, i.e. D, T, and C respectively, and it is the complement that is elided. Obviously, this standard assumption does not apply to NP in the left-branching structure of (43), where NP is the head, not the complement. Thus, the NP ellipsis in (43) must not be a case of complement ellipsis but a case of head ellipsis, or gapping, similar to cases in (44) and (45).

(44) a. dental ~~technology~~ and food technology
b. business ~~conditions~~ and financial conditions
c. Mary read two books, and John read five ~~books~~.
d. She has two children but wants more ~~children~~.
e. She was singing, and ~~she was singing~~ beautifully.
f. Q: Are you coming? A: Yes, ~~I'm coming~~ in a minute.

(45) a.

你	穿	大號	西裝,	我	穿	中號	~~西裝~~
ni	*chuan*	*dahao*	*xizhuang*	*wo*	*chuan*	*zhonghao*	~~*xizhuang*~~
you	wear	large	suit	I	wear	medium	suit

'You wear large-size suits, I wear medium-size.'

b.

你	喜歡	白色	襪子	還是	黑色	~~襪子~~？
ni	*xihuan*	*baise*	*wazi*	*haishi*	*heise*	~~*wazi*~~*?*
you	like	white	sock	or	black	sock

'Do you like white or black socks?'

c.

他	有	很多	書，	我	也	有	很多	~~書~~
ta	*you*	*henduo*	*shu*	*wo*	*ye*	*you*	*henduo*	~~*shu*~~
he	have	lots-of	book	I	too	have	many	book

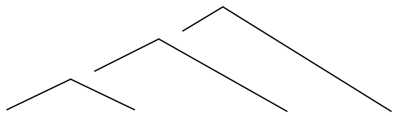
'He has lots of books, I too have many.'

Recall property (6), that N is the head. Thus, though property (2) favors neither the left- nor right-branching analysis (property (6) and property (2) taken together), the left-branching analysis has a distinct advantage.

Property (3), where C/M can also be elided, if N is also elided and Num is a high number and a round figure, may seem to favor right-branching, where [C/M N] forms a constituent. However, the reality is just the opposite. As pointed out in §3, the reason a high number round figure is required for this ellipsis is because such a number, e.g. 三百 *sanbai* '300', has precisely the same underlying mathematical structure [*multiplier* × *multiplicand*] that [Num C/M] has. This thus indicates once again that [Num C/M] forms a constituent, excluding N. Ellipsis of N and that of C/M thus happen independently and successively, first N and then C/M, both head-ellipsis.

Having [Num C/M] as N's modifier also affords property (4) a simple uniform treatment, where [C/M N] as a single constituent merges with -*de*, as shown in (46). Even though the exact syntactic status of *de* is controversial, there is a clear consensus that -*de* introduces a modifier in [[XP-*de*] N]. A left-branching analysis enjoys this simple analysis of -*de*. A right-branching structure must have -*de* inserted between the head C/M and the complement NP, without having [Num C/M] as a constituent.

(46) Unified left-branching structure with *-de*



Num	C/M	*-de*	N
san	*ben/xiang*	*-de*	*shu*
three	C/M-box	DE	book

However, (46) does have its drawbacks, as keenly observed by Zhang (2011), who raises two objections. First, as mentioned earlier, pre-C modifiers and Num must scope over N, but the left-branching structure does not allow this as the pre-C modifiers do not c-command N. Second, C also does not c-command N and thus it is difficult for individual C's to impose selectional restrictions on N. We shall address these problems in §5.2, taking advantage of LFG's f-structure.

Property (5), where Num is optional only if its value is precisely *one*, also favors left-branching. Again, the math behind [Num C/M] is uniformly of the structure [*multiplier* × *multiplicand*], and therefore, as seen in (16) in §2.2, C, the *multiplicand* with the precise value of *1*, can be omitted if the style requires. Likewise, when Num, the *multiplier*, has the precise value of *1*, it too can be omitted. A right-branching structure, where [Num C/M] do not form a constituent at all, does not afford this insight.

Finally, the seventh common property, that both C/M allow *ban* 'half' or *duo* 'more' to follow, also favors the left-branching tree, where [Num C/M *ban*/*duo*] form a single constituent as a coherent quantifier of N and also receive a natural analysis, i.e. [[Num × C/M] + *ban*/*duo*], one that resembles natural numbers, e.g. [[8 × 10] + *3*] for 八十三 *ba shi san* '83'. The right-branching structure, [Num [C/M N]], does not possibly allow [Num C/M-*ban*/*duo*] to form a constituent and thus fails to account for the mathematics in this construction.

The evidence so far thus favors the unified left-branching analysis. But before we move on to solve the scope problems, we shall examine another crucial support, from word order typology. In his seminal paper entitled 'On the history of classifiers in Archaic and Medieval Chinese', Peyraube (1998) establishes that there have been six word orders in total as far as Num, C/M, and N are concerned, as shown in (47a).[7] Note that, with C/M taken to be of the same category, the six patterns can be reduced to two groups, as in (47b).

[7] Peyraube (1998) in fact listed one more word order, N_1 + Num + N_2, and thus seven all together. However, this order is merely an instance of (47a), Num + N and thus is not included. There are essentially just six word orders.

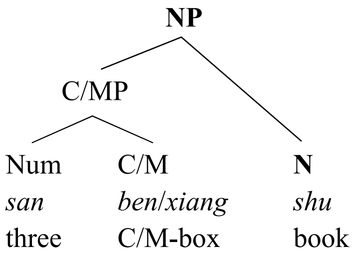
(47) a. Six word orders among Num, C/M, and N in history (Peyraube 1998)
- i. Num + N
- ii. N + Num
- iii. Num + C + N
- iv. N + Num + C
- v. Num + M + N
- vi. N + Num + M

b. Six word orders reduced
- i. Num + N; N + Num
- ii. Num + C/M + N; N + Num + C/M

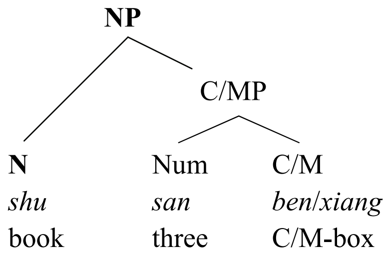
It is most telling that the two orders within each pair are mirror images if the [Num C/M] sequence is taken to be a constituent, which we shall call C/MP. Note also that the first pair in (47b) are without C. As we have already seen, even in today's Chinese, C is optional stylistically; [Num (C)] can therefore be seen as an instance of C/MP as well. The end result of this reduction is shown in (48), i.e. the six actual orders in the 3000 years of history can be rather elegantly accounted for by the head parameter under the assumption of the [Num C/M] constituency and N as the head in the left-branching [[Num C/M] N]; this result is shown in (48a) and (48b).

(48) Attested word orders in Chinese history and cross-linguistically

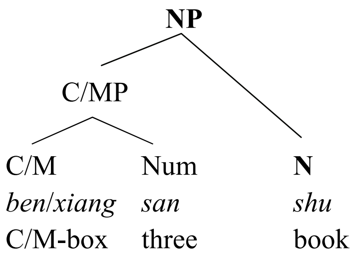
a. N: head-final; C/M: head-final



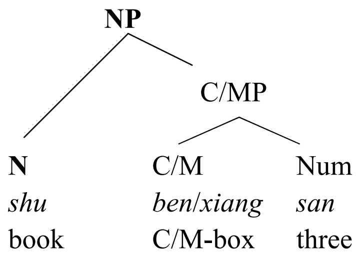
b. N: head-initial; C/M: head-final



a′. N: head-final; C/M: head-initial



b′. N: head-initial; C/M: head-initial



Note that the head parameter likewise applies to C/MP, where C/M is taken to be the head. The end result of applying the head-parameter on both C/M and N, shown in (48), is exactly the four attested word orders that Greenberg (1990a:185) has found in the classifier languages of the world, confirmed also by Aikhenvald (2000:104-105) in her influential book. A single c-structure where [Num C/M] forms a constituent first, either head-initially or head-finally, before merging with the head noun, again in either a head-initial or head-final fashion, comprehensively and accurately accounts for the word orders in language. A unified right-branching account or a split c-structure account, on the other hand, would over-generate as well as under-generate.

(49) Word orders predicted by [C/M N] constituency

a. [Num [C/M N]]

Num	C/M	**N**
san	(*ben*)/*xiang*	*shu*
three	C/M-box	book

b. *[Num [N C/M]]

Num	**N**	(C)/M
san	*shu*	(*ben*)/*xiang*
three	book	C/M-box

a′. *[[C/M N] Num]

C/M	**N**	Num
(*ben*)/*xiang*	*shu*	*san*
C/M-box	book	three

b′. [[N C/M] Num]

N	(C)/M	Num
shu	(*ben*)/*xiang*	*san*
book	C/M-box	three

Under the [C/M N] constituency, there are also four possibilities, as shown in (49). Yet, (49a′) and (49b′) are predicted to be viable options for Chinese, incorrectly; furthermore, (49b) and (49a′) do not appear in any language. The [C/M N] constituency also fails to account for the [N Num C/M] order, which did occur in Chinese history and also elsewhere, and the attested [C/M Num N] order.

One might adopt (49a) in the mainstream derivational framework and resort to movement to account for the attested historical and cross-linguistic word order variations in (48). As a concrete illustration, Cinque (2005) proposes a single, universal, order of Merge, shown in (50) and also a leftward NP-raising to account for the word order variations in the nominal structure cross-linguistically.

(50) Universal order of Merge in the nominal structure (Cinque 2005)

[Q_{univ}.. [Dem.. [Num_{ord}.. [RC.. [Num_{card}.. [Clf.. [A.. NP]]]]]]]

Relevant to our discussion is this order of merge, Num > C/M > N. The unmarked option in languages, e.g. Modern Chinese, is thus [Num [C/M N]], precisely the right-branching account. Mathematically, there are six possible orders among Num, C/M, and N, and as seen in (48), only four are attested. Let us see how Cinque's proposal actually fares in accounting for the C/M word order typology.

(51) Word orders derived following Cinque's (2005) proposal

a. [Num C/M N] (*attested*)
N does not raise; can be derived.
Prediction correct.

b. [N Num C/M] (*attested*)
N raises around C/M and Num; can be derived.
Prediction correct.

c. [C/M Num N] (*attested*)
N does not move, but the two elements to its left are in the wrong order of merge; cannot be derived.
Prediction incorrect*; *under-generates.

d. [N C/M Num] (*attested*)
N moves around C/M and Num with Pied-piping of the *whose picture*-type; can be derived.
Prediction correct.

e. [C/M N Num] (*unattested*, *no languages*)
N raises one notch with Pied-piping of *picture of who*-type; can be derived.
Prediction incorrect*; *over-generates.

f. [Num N C/M] (*unattested*, *no languages*)
N moves around C/M, with vacuous Pied-piping of the *whose picture*-type; can be derived.
Prediction incorrect*; *over-generates.

Like the non-movement account of [C/M N] constituency, the application of Cinque's (2005) movement-based proposal also leads to over-generation as well as under-generation. The unified left-branching account in (48) is straightforward and simple, and should thus be preferred.

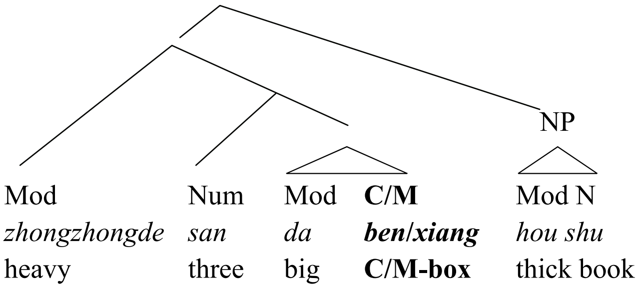
5.2 An f-structure analysis

Something must give, if not in the c-structure, then it must be in the f-structure, to account for the C/M differences in scope phenomena. Likewise, the fact that the left-branching c-structure, repeated in (52), fails to account for the agreement relation between C and N indicates this relation needs to be accounted for in the f-structure.

(52) Unified left-branching structure

a. 重重的 三 大 本 厚 書
zhongzhongde san da ben hou shu
heavy three big C thick book
'three heavy big thick books'

b. 重重的 三 大 箱 厚 書
zhongzhongde san da xiang hou shu
heavy three big M-box thick book
'three heavy big boxes of thick books'



The solution is clear: C and N must be co-heads in terms of f-structure, while M heads its own phrase as N's quantifier. Other cases of co-heads are generally between a functional category and its structural complement, e.g. D and NP, T and VP, C and TP. Adopting the notion that C is more functional than M (e.g. Kubo 1996, Vos 1999, van Riemsdijk 1998, and H&H), C naturally serves as a co-head of N, and thus anything that scopes over C must scope over its co-head N. In addition, as co-heads, C and N must have compatible f-structure information and this is exactly how C-N agreement is accomplished. In fact, Hsieh (2009), Her (to appear), Her & Lai (to appear), and Her & Hsieh (2011)'s insight that C functions cognitively as a profiler can be easily implemented as f-structure features in C as well as N. A sample of the relevant lexical entries is given in (53), with irrelevant and minor details left out.

(53) Sample Lexical Entries

a. *shu* 書 N
(↑ PRED) = 'BOOK'
(↑ PROFILABLE) = {BEN 本, CE 冊}

b. *san* 三 Num
($\uparrow$ CARD) = 3

c. *ben* 本 CM
($\uparrow$ PROFILED) = BEN 本

d. *xiang* 箱 CM
($\uparrow$ PRED) = 'BOX'

Note first that classifiers (C) and measure words (M) are assigned to a single lexical category, i.e. CM. This captures the fact that they share the same c-structures and are thus mutually exclusive. Their differences are located in f-structure. C has no PRED, but M does; C, however, has a feature PROFILED, whose value is the essential property each C serves to highlight. Note also that, though a C profiles an essential feature of the N, it does not mean a noun can only have one of its essential features profiled. Indeed, a noun may co-occur with one or more C's, though only one at a time as a formal requirement. 書 *shu* 'book', for example, normally takes the C *ben* 本, but *ce* 冊 is also an option. This is accounted for by the feature PROFILABLE of count nouns, which takes a set, e.g. {BEN 本, CE 冊}, as its value. A sample of relevant annotated phrase structure rules is given in (54), again with irrelevant and minor details left out.

(54) Sample Annotated Phrase Structure Rules

a. NP → … CMP … N
($\downarrow$ PRED) =>[8] $\uparrow$=$\downarrow$
($\uparrow$ QUANTIFIER) = $\downarrow$
¬ ($\downarrow$ PRED) =>
$\uparrow$=$\downarrow$
($\downarrow$ PROFILED) $\in_c$ ($\uparrow$ PROFILABLE)[9]

b. CMP → … Num … CM
$\uparrow$=$\downarrow$ $\uparrow$=$\downarrow$
(($\uparrow$CARD) = 1)[10]

---

[8] I follow Falk (2001) in using a more straightforward notation 'A ⇒ B' to express 'IF A THEN B' in LFG. Mary Dalrymple (p.c.) has suggested to me that in LFG 'IF A THEN B ELSE C′ can be expressed as { ¬A C | A B }, meaning either [NOT-A AND C] or [A AND B], thus either we have A and then we also have B, or we do not have A and in that case we have C, making C the elsewhere condition. Thus, 'IF A THEN B' can be expressed as { ¬A | A B }.

[9] The expression 'A $\in_c$ B' means 'A must be a member of B'.

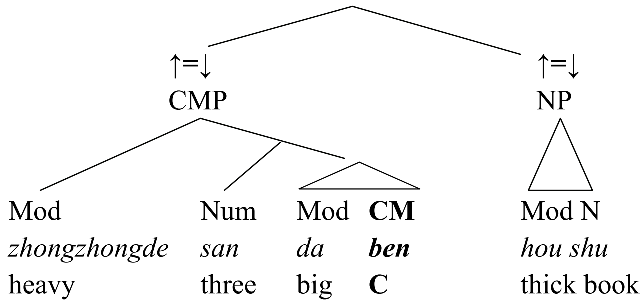
[10] The parentheses around an entire functional expression E indicates that E is optional.

The rule of (54b) builds CMP straightforwardly, where Num and CM are co-heads. The last equation is optional, which accounts for the fact that the numeral 1 may be optional. In (54a), CMP is first checked and see if it contains PRED. If it does, then it serves as a QUANTIFIER function to the head NP. If it has no PRED, then CMP is a co-head to N, and the agreement between its PROFILED feature and N's PROFILABLE feature is then accomplished by the constraint that the value of the former, e.g. *ben* 本, must be a member of the set value of the latter, e.g. {BEN 本, CE 冊}.

Tying it all together, the split f-structures that C/M project are shown in (55a) and (55b), respectively, with information of various modifiers also schematically indicated. Note that, following Falk (2001), the use of double quotes is a shorthand to get around giving detailed information in a subsidiary f-structure, thus similar to the use of triangles in c-structures.

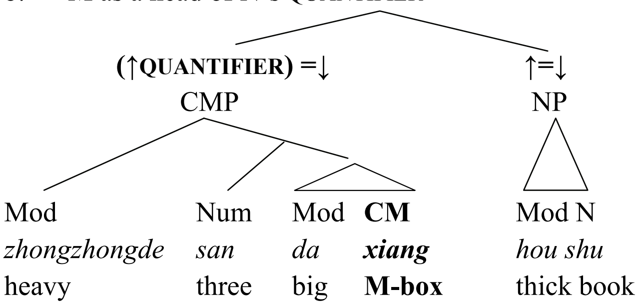
(55) Split f-structure

a. C as a co-head of N



$$\left[\begin{array}{ll} \text{PRED} & \text{‘BOOK’} \\ \textbf{PROFILED} & \textbf{BEN 本} \\ \text{PROFILABLE} & \{\text{BEN 本, CE 冊}\} \\ \text{CARD} & 3 \\ \text{ADJUNCTS} & \left\{\begin{array}{l} [\text{“heavy”}] \\ [\text{“big”}] \\ [\text{“thick”}] \end{array}\right\} \end{array}\right]$$

b. M as a head of N’s QUANTIFIER



$$\left[\begin{array}{ll} \text{ADJUNCTS} & \{[\text{“thick”}]\} \\ \text{PRED} & \text{‘BOOK’} \\ \text{PROFILABLE} & \{\text{BEN 本, CE 冊}\} \\ \text{QUANTIFIER} & \left[\begin{array}{ll} \text{PRED} & \text{‘BOX’} \\ \text{CARD} & 3 \\ \text{ADJUNCTS} & \left\{\begin{array}{l}[\text{“heavy”}] \\ [\text{“big”}]\end{array}\right\} \end{array}\right] \end{array}\right]$$

Within this f-structure analysis, C/M differences in adjectival and quantification scope as well as C-N agreement can all be captured. Central to this f-structure solution is allowing C, but not M, to be a co-head with N.

6. Concluding remarks

This paper is concerned with the syntactic analysis of classifiers (C) and measure words (M) in a [Num C/M N] phrase. C/M differ semantically in that C profiles an essential feature of the noun, while M provides accidental features to the noun. Mathematically, the [Num C/M] constituent and high number round figures share the same internal multiplication-based structure, e.g. 三百 *san bai* ‘300’ and 三打 *san da* ‘3 dozens’ are analyzable as [3 × *bai*/*da*], or [3 × *100*/*12*]. Thus, C/M function alike as the multiplicand, with Num as its multiplier; yet, C/M differ in their value, C = *1*, M = ¬*1*. Cognitively, C uniquely serves the function to *profile* an essential feature in the semantic frame provided by the head noun.

Grammatically, C/M differ in scope phenomena. While C is transparent, in that it allows numeral quantification and adjectival scope to include N, M is opaque. Otherwise, C/M behave the same and share seven common properties: (1) C/M are mutually exclusive, (2) N can be elided, (3) C/M can also be elided along with N, if Num is a high number round figure, (4) C/M both allow *-de* insertion, (5) Num is optional if its equals *one*, (6) N is the head, and (7) C/M both allow *ban* 'half' and *duo* 'more' to follow.

Previous syntactic accounts come in two varieties, exhausting the two logical options: unified analysis for C/M and split analysis for C/M. Within the unified camp, some propose a uniform left-branching structure, others right-branching. The left-branching option captures the parallel internal structure of high number round figures, i.e. [*n* × *base*], and that of [Num C/M] as a constituent, but fails to offer a configurational account for C/M differences in scope phenomena. The right-branching counterpart is just the opposite. It fails to capture the parallel internal structure of high number round figures and that of [Num C/M], which is not a constituent at all, but it does allow a structural account for C/M differences in scope phenomena, where C is assumed to be more functional and thus less lexical than M. A split analysis, where C appears in a left-branching structure and M right-branching, nicely accounts for C/M differences in scope phenomena straightforwardly in terms of c-command, but now what C/M have in common cannot be generalized and each common property needs to be analyzed differently structurally.

The solution offered for this catch-22 dilemma is formulated in the framework of Lexical Functional Grammar (LFG), where syntax is factored into a (constituent) c-structure and a (functional) f-structure. The phrase [Num C/M N] is argued to have a uniform left-branching c-structure, which best captures the seven properties C/M have in common as well as the underlying mathematical structure of [*multiplier* × *multiplicand*] between Num and C/M. The C/M differences in scope are captured in f-structure, where C and N are co-heads. Whatever modifies C thus also modifies N. Agreement between C and N is likewise naturally accounted for by the two co-heads' unification. M, on the other hand, heads its own projection and forms the QUANTIFIER function of the head noun.

To the extent that such a solution to the C/M dilemma is difficult in a purely constituent-based framework but it is not only available but also rather natural within LFG's parallel architecture of c- and f-structures, having a separate independent feature structure proves to be on the right track and needs to be seriously considered as an integral part of UG.

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Graduate Institute of Linguistics &
Research Center of Mind, Brain, and Learning
National Chengchi University
64, Sec. 2, Zhinan Road
Taipei 116, Taiwan
hero@nccu.edu.tw

分類詞與量詞的句法結構：詞彙功能語法的分析

何萬順

國立政治大學

對於數詞 (Num)、分類詞與量詞 (C/M)、名詞 (N)，如「三匹馬」或「三箱書」，三者之間的結構，先前的看法可分三種，一是 [Num C/M] 先形成詞組，二是 [C/M N] 先形成詞組、三是兩種結構都需要。本文主旨在於論證 [Num C/M] 的結構不僅能捕捉 C/M 兩者之間的共通性（例如兩者在數學上均可解讀爲被乘數，其質分別爲 *1* 與 ¬*1*），同時在類型學上也能完整解釋 [Num C/M N] 在語言中存在的四種詞序；相形之下，另外兩種看法均會產生過度生成 (overgeneralization) 與生成不足 (undergeneralization) 的缺失。本文並在詞彙功能語法 (Lexical-Functional Grammar, LFG) 的理論架構下對漢語分類詞與量詞做出形式分析。C/M 兩者的詞組結構 (c-structure) 相同；但其功能結構 (f-structure) 不同：分類詞與 N 同爲中心語 (co-heads)，在此也表現出分類詞如何彰顯 (profile) N 的某項本質特徵，而量詞的功能則是 N 的 QUANTIFIER。

關鍵詞：分類詞，量詞，詞組結構，功能結構，彰顯，乘法，被乘數