Chinese quantifier scope, concord, and Lexical Resource Semantics

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Abstract

This paper considers Chinese quantifier scope, an important, outstanding area of Chinese linguistics. In particular, there are two open questions on the subject: (1) the guiding principles that determine (a) the scopal readings of quantifiers and (b) the sometimes mandatory co-occurrence of the universal quantifier *mei* (every) and the universal adverb *dou*, and (2) the semantic functions of *mei* and *dou* and their connection to the co-occurrence of these words.

We reappraise three prior accounts of these subjects, reason through their consequences on some exemplary data, offer a new explanation based upon concord, a mechanism that is commonplace in many languages, and formulate it in lexical resource semantics (LRS). We use two principles adapted from Richter & Sailer's (2004) analysis of negative concord, expanded with a new quantifier order constraint to generate a coherent answer to the two aforementioned questions.

1 Introduction

Chinese quantifier scope is one of the most provocative areas of Chinese linguistics. In this article, we will examine the universal *mei*-NP (every-NP), the existential *yi*-NP (one-NP), and the multi-functional adverb *dou* in Mandarin Chinese. *mei*-NPs take the form of *mei*-(*yi*)-CL-N (every-(one)-classifier-N), with the number *yi* (one) being optional. *yi*-NPs take the form of *yi*-CL-N (one-classifier-N).

Chinese quantifier scope is intriguing because of its cosmetic resemblance to logical form. Unlike in English, where both the surface scope reading and the inverse scope reading are available at all times (1), the availability of scopings in Chinese is asymmetric. When the existential quantifier phrase (QP) precedes the universal QP (2a), only the surface reading is available; however, when the two QPs are flipped (2b), the inverse reading becomes available. Furthermore, topicalisation drastically changes the availability of readings (2c, 2d).

(1)   a. Every student read a book.

   ($\forall > \exists$) ($\exists > \forall$)

   b. A student read every book.

   ($\exists > \forall$) ($\forall > \exists$)

(2)   a. 一个　学生　　读过　　每本　书
      yī-gè　xuéshēng dú-guò　měi-běn shū
      one-CL student　read-ASP every-CL book

   ($\exists > \forall$) (*$\forall > \exists$)

   b. 每个　学生　　都　读过　一本　书
      měi-gè　xuéshēng dōu dú-guò　yī-běn shū
      every-CL student　DOU read-ASP one-CL book

   ($\forall > \exists$) ($\exists > \forall$)

c. 一本　书　每个　学生　*(都) 读过
yī-běn shū měi-gè xuéshēng dōu dú-guò
one-CL book every-CL student DOU read-ASP
(∃ > ∀) (*∀ > ∃)

d. 一个　学生　每本　书　*(都) 读过
yī-gè xuéshēng měi-běn shū dōu dú-guò
one-CL student every-CL book DOU read-ASP
(∃ > ∀) (*∀ > ∃)

What are the guiding principles that determine quantifier scope readings?

More controversially, the adverb *dou* (often glossed as ALL) often co-occurs with *mei* (3a). This co-occurrence is puzzling as both *mei* and *dou* imply a universal quantifier. In other languages, English for example, *every* and *all* cannot co-occur (3b). Furthermore, what is the semantic function of *dou*? Does it affect the rendering of quantifier scope?

(3)　a. 每个　三年级　学生　*(都) 来了
měi-gè sānniánjí xuéshēng *(dōu) lái-le
every-CL third-grade student DOU come-ASP
'Every third grade student came.'

　b. Every third grade student (*all) came.　(Liu (2021), ex.6)

Wu (2019) explained Chinese quantifier scope as a product of principles of economy. Lin (1998) presented a decompositional analysis of *mei* and *dou* and argued that this phenomenon should be analysed as a matter of distributivity rather than quantifier scope. Liu (2021) more recently defended the opposite view, in which a quantifier-scope analysis is necessary, and analysed *dou* as pragmatic. Here, we propose a novel theory that the placement of Chinese *dou* can be understood as an instance of concordant universality. We argue that the co-occurrence of *mei* and *dou* is analogous to negative concord in languages such as Polish; negation also exhibits scoping effects. This novel approach leads to a massively simplified analysis. Finally, we are able to present a simple but effective lexical resource semantics (LRS) analysis of Chinese quantifier scope.

2 Chinese Quantifier Scope

2.1 Principles of Economy and Topic Prominence

Fox's (2000) analysis, based on principles of economy, is one of the theories proposed to explain quantifier scoping. He gave a detailed account of how an English sentence such as (1b) can yield both the surface scope (∃ > ∀) and the inverse scope (∃ > ∀) through a series of scope-shifting operations (SSO). The Chinese sentence (2a) has a parallel syntax to its English counterpart (1b), however, and yet the inverse scope reading is not available for the Chinese sentence.

Wu (2019) argued that this mismatch is not a refutation of Fox's (2000) theory. Instead, it suggests that "Mandarin matrix transitives do not have the same syntactic structure as English matrix transitives have." Expanding upon the well-known observation that Chinese is a topic-prominent language (Chao, 1968), Wu (2019) further argues that Chinese is topic-prominent in the sense that there exists a TopP projection above the TP for matrix clauses. The presence of this extra layer of TopP makes the optional QR or QL impossible, because they violate scope economy. As those optional QR and QL were the source of the quantifier scope ambiguity, the example (2a) now becomes unambiguous.

The economy analysis on the other hand fails to predict the available quantifier scopings of the doubly topicalised sentence (2d). Since both QPs are topicalised, the semantics-changing QR should be allowed to happen. Therefore, under Wu's (2019) theory, (2d) should have both the surface and inverse quantifier scope readings. But this never comes to light — Wu (2019) limits itself to analysing only sentences in which the existential QP precedes the universal quantifier, and also ignores any sentences that have the multi-functional adverb *dou*. If such sentences are also considered, one can easily find counterexamples to this analysis. While (2b) has the same linear order of parts of speech as (2a), the sentence becomes scope-ambiguous if only the quantifier placement is reversed (universal precedes existential). Wu (2019) argues that these sentences are not evidence of scope ambiguity, because the inverse scope reading implies the surface reading: if every student read the same book, then every student did read a book. The existence of the inverse reading is merely an instance of the more general reading. Under this view, many English sentences are also not scope-ambiguous, however.

Nevertheless, there are sentences in which only the surface reading is available. As pointed out by Lin (2020), the co-occurrence of *dou* and *mei* is not always mandatory. When *dou* is omitted, the sentence (4) can only yield the surface-scope reading. This important observation shows that understanding the semantic function of *dou* and its interaction with the quantifier *mei* are crucial for analysing Chinese quantifier scope.

(4) 每个　　学生　　读过　　一本　书
　　 měi-gè　 xuéshēng dú-guò　 yī-běn shū
　　 every-CL student　 read-ASP one-CL book
　　 ($\forall > \exists$) (*$\exists > \forall$)

2.2 Decompositional Account of *mei* and *dou*

Liu (2021) considers "the puzzle of co-occurring *mei* and *dou*." Both the quantifier *mei* and the multi-functional adverb *dou* introduce universal quantifiers, and therefore it is puzzling why *mei* and *dou* need to co-occur, let alone mandatorily in some situations. After all, the co-occurrence of *every* and *all* is not allowed in English (3).

One intriguing solution to this puzzle is presented by Lin (1998, 2020). He

suggests that *mei* is not inherently quantificational. In his framework, *mei* has a semantics similar to the definite article *the*, which marks an NP as a "maximally plural" entity. Then Lin (1998) defines *dou* as a distributive operator (Link, 1987). Thus, the puzzle is solved by analysing the sentences not through the lens of quantifier scoping, but through distributivity.

(5)   a.   [[*mei*]] = f, such that $\forall P \in D_{<e,t>}, f(P) = \cup ||P||$ (Lin (1998): (68))

        b.   [[*dou*]] = $\lambda P.\lambda x.\forall y.[y \leq_{atom} x \rightarrow P(y)]$ (Link, 1987)

2.3 Presuppositional Account of *dou*

Liu (2021) posits a view opposite to Lin's (1998) decompositional solution, after laying out a detailed list of damning evidence that *mei*-NPs must indeed be quantificational. While we shall not reiterate all of the evidence here, one interesting observation is that when *mei*-NPs appear in a post-verbal position, *dou* is not allowed to appear, cf. example (2a).

Having concluded that *mei* is quantificational, Liu (2021) posits that "*dou* is truth-conditionally vacuous but carries a presupposition that its prejacent is the strongest among its alternatives." This almost suggests that the appearance of *dou* is optional, however, and yet we know that the co-occurrence of *mei* and *dou* is often mandatory (2a, 3a). To address the phenomenon of obligatory *dou*, Liu (2021) resorts to a pragmatic analysis of *obligatory presupposition* (Amsili & Beyssade, 2010).

There are certain aspects of the occurrence of *dou* that cannot be purely explained with pragmatics. Firstly, the scope-reading difference between (2b) and (4) cannot be explained as a difference between whether presuppositions are specified. The semantic difference between the two suggests that *dou* possesses a genuinely semantic import of universality. Secondly, while (6a) is ungrammatical regardless of whether *dou* occurs, (6b) is grammatical only with an obligatory *dou*. The only difference between the two sentences is that the subject of (6a) is existentially quantified, and (6b) has a proper noun as its subject that does not introduce any new quantifier. But the two sentences have no difference in what Liu (2021) terms their "propositional alternatives," as the existential quantifier does not introduce plurality, and therefore according to Liu (2021), both sentences should be grammatical with an obligatory *dou*.

(6)   a.   *每本　书　一个　学生　(都) 读过
           měi-běn shū yī-gè xuéshēng dōu dú-guò
           every-CL book one-CL student   DOU read-ASP

        b.   每本　书　张三　*(都) 读过
           měi-běn shū zhāngsān dōu dú-guò
           every-CL book Zhangsan DOU read-ASP

3   *mei* and *dou* are Multi-functional

Nevertheless, we would not claim that *mei* and *dou* are purely quantificational. On the contrary, there does appear to be a distinction between decompositional *mei* for dependent indefinites and the quantificational *mei* that co-occurs with *dou*, and between a pragmatic, presuppositional *dou* and the quantificational *dou* that co-occurs with *mei*. We dispute Lin (1998, 2020) and Liu's (2021) goal of formulating a unified account of the three functions.

The analysis in this paper only considers quantificational *mei* and *dou*. When the subject NP is a dependent indefinite (7a), a decompostional analysis should apply. Dependent indefinites are discussed at length in Lin (2020). A dependent indefinite NP takes the form of *mei*-num-CL (7a). When the number is greater than one, then the NP is unambiguously dependent indefinite. Sentences with these dependent indefinite NPs are drastically different from the regular quantificational *mei*-NPs that we have examined so far. For dependent-indefinite NPs, *dou* is forbidden, and they cannot undergo any topicalisation (7b). They are also more restrictive about the order in which their quantification can be read relative to other QPs: only universal preceding existential is allowed (7c). Because of all of these differences and, more crucially, the lack of the presence of *dou*, it remains exceptional. It is also worth noting that when the number is one in *mei*-num-CL, the NP is ambiguous between being a dependent indefinite and a regular quantificational *mei*-NP; recall that *yi* (one) is optional in regular *mei*-NPs.

(7)   a.   每三个　　学生　　(* 都) 读过　　一本　书
　　　　　mǐi-sān-gè xuéshēng (*dōu) dú-guò　yī-běn shū
　　　　　every-3-CL student　DOU　read-ASP one-CL book
　　　　　(∀ > ∃) (*∃ > ∀)

　　　b.   *一本　书　　每三个　　学生　　读过
　　　　　yī-běn shū　mǐi-sān-gè xuéshēng dú-guò
　　　　　one-CL book every-3-CL student　read-ASP

　　　c.   *一个　学生　　读过　　每三本　　书
　　　　　yī-gè　xuéshēng dú-guò　mǐi-sān-běn shū
　　　　　one-CL student　read-ASP every-3-CL　book

　　　d.   每 (一) 个　学生　　(都) 读过　　一本　书
　　　　　mǐi-(yī)-gè xuéshēng (dōu) dú-guò　yī-běn shū
　　　　　every-(1)-CL student　DOU　read-ASP one-CL book

As we have discussed, the co-occurrence of *mei* and *dou* is not purely pragmatic. There is, however, a purely presuppositional usage of *dou*, shown in (8). This presuppositional *dou* does not introduce any genuinely semantic import. Unless it is a part of another presuppositional construction (e.g., the *lian-dou* construction in (8c)), adding or removing *dou* does not change syntactic well-formedness (8a, 8b). Presuppositional *dou* is certainly different from quantificational *dou*. As shown in

(8d), if the subject of the sentence is a universal QP (*mei-ge xuesheng*, *every student*), the sentence cannot be grammatical. This demonstrates a clear distinction between the different senses of *dou*; it is impractical to pursue a unified analysis of them.

(8) a. 张三　　找到　　工作　了
　　　zhāngsān zhǎo-dào gōngzuò le
　　　Zhangsan found　　job　　ASP
　　　Zhangsan has found a job.

b. 张三　　都　找到　　工作　了
　　　zhāngsān dōu zhǎo-dào gōngzuò le
　　　Zhangsan DOU found　　job　　ASP
　　　Even Zhangsan has found a job.

c. 连　张三　　*(都)　找到　　工作　了
　　　lián zhāngsān *(dōu) zhǎo-dào gōngzuò le
　　　LIAN Zhangsan DOU　found　job　　ASP
　　　Even Zhangsan has found a job.

d. *连　每个　学生　(都)　找到　　工作　了
　　　lián měi-gè xuéshēng (dōu) zhǎo-dào gōngzuò le
　　　LIAN every student DOU found　　job　　ASP

4　"Universal Concord"

Both Lin (1998) and Liu (2021) saw the co-occurrence of *mei* and *dou* as a puzzling anomaly that is unique to Chinese, and yet the phenomenon of multiple words being allowed or even required to repeat a single semantic contribution in different parts of a sentence is commonplace in many languages. For example, negative concord (Sailer & Richter, 2021; Richter & Sailer, 2004) is a well-known phenomenon expressed typically in Polish (9a). Polish n-words (such as *nikt*, *nobody*) inherently express negativity. When an n-word appears in a clause, however, the verb must be marked by the Polish negative marker *nie*, often glossed as NM. Furthermore, the repeated negation does not yield a doubly negated reading ($\neg\neg(\exists x.\texttt{human}(x) \wedge \texttt{came}(x))$), but rather only a *negative-concord* reading ($\neg(\exists x.\texttt{human}(x) \wedge \texttt{came}(x))$) that is semantically equivalent to a simple negation. Negative concord is expressed colloquially in English as well; (9b) is logically equivalent to "I don't know anything."

(9) a. Nikt　　nie przyszedł.
　　　nobody NM came
　　　'Nobody came.'

b. I don't know nothing.

c. 没 人　　 没 来
méi rén　　 méi lái
NM person NM come
'Nobody didn't come.'

Liu (2021) and Lin (1998) both used the incompatibility of *every* and *all* in English as evidence that the co-occurrence of *mei* and *dou* are problematic, and indeed concord can be idiosyncratic. For example, Chinese expresses no negative concord; (9c) can only have the doubly negated reading ($\neg\neg(\exists x.\texttt{human}(x) \wedge \texttt{came}(x))$), in which "everybody came."[1] A language expresses concord as the result of language-specific constraints. LRS provides us a simple but powerful framework to analyse and describe these language-specific constraints. In the following section, starting from our Polish negation reference, we present an analysis of example (2b): *mei-ge xuesheng dou du-guo yi-ben shu* (*every*-CL *student* DOU *read one*-CL *book*).

5   The Analysis

Building the NP   We can start our analysis by constructing the two NPs *mei-ge xuesheng* (*every student*). The relevant parts of the lexical entries of the quantifier (*yi-ben*, *a*) and the noun (*shu*, *book*) can be found in (10). The internal content (INCONT) expresses the semantic composition of a sign. It is the scopally lowest semantic contribution of the semantic head. The external content (EXCONT), on the other hand, expresses the contribution of the maximal projection of the sign. The symbol $\lhd$ indicates a subterm relationship: $\boxed{2} \lhd \boxed{3}$ means that $\boxed{2}$ is a subterm of $\boxed{3}$. As a shorthand, we also use square brackets to denote a subterm relationship (the subterm appears inside the brackets as a description of the superterm). The conjunction in $\boxed{1}$, $([y] \wedge [y])$, means that the bounded variable y is a subterm of both the left- and right-hand conjuncts, i.e., it is a shorthand for $(\alpha \wedge \beta)$ & $y \lhd \alpha$ & $y \lhd \beta$. Finally, the content of the PARTS list is determined by the Incont Principle (IContP) and the Excont Principle (EContP). The IContP states that the INCONT value is an

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[1]A participant at the conference asked us whether there is other evidence of concord in Chinese. The closest that we have found are occurrences of *suiran …danshi* (*although …but*) and *yinwei …suoyi* (*because …therefore*):

(1)　(虽然)　 我 很 丑 但是 我 很 温柔
　　 (suīrán)　 wǒ hěn chǒu dànshì wǒ hěn wēnróu
　　 (although) I　 very ugly but　 I　 very kind

　　 Although I am ugly, I am kind.

(2)　(因为)　 我 很 穷 所以 我 没 钱 吃饭
　　 (yīnwèi)　 wǒ hěn qióng suǒyǐ　 wǒ méi qián chīfàn
　　 (because) I　 very poor therefore I　 no money eat

　　 Because I am poor, I can't afford food.

These appear more coordinated than concordant, however, and the occurrence of both *suiran* and *yinwei* is optional.

element of the PARTS list and a component of the EXCONT value. Therefore, we can know that in *yi-ben* (*a*), $\boxed{1} \lhd \boxed{2}$ and $\boxed{1}$ is a member of PARTS; and for the noun *shu* (*book*), $\boxed{3} \lhd \boxed{4}$ and $\boxed{3}$ is in its PARTS list. The EContP stated that every subexpression of the EXCONT value is an element of the utterance's PARTS list. Therefore, the unbound variable Y and the non-logical constant book are both in the PARTS list of the noun. For the classifier phrase *yi-ben*, the bound variable y and the conjunction $\boxed{1a}$ $[y] \wedge [y]$ are both members of the PARTS list. Additionally, because it is the non-head daughter of the NP, its EXCONT ($\boxed{2}$) is also a member of the PARTS list.
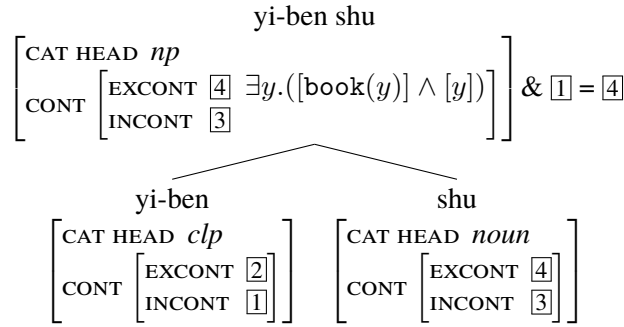
(10)　a.　Part of the lexical entry of *yi-ben*:

$$\begin{bmatrix} word \\ \text{PHON } \langle yi\text{-}ben \rangle \\ \text{SL} \begin{bmatrix} \text{CAT HEAD } clp \\ \text{CONT} \begin{bmatrix} \text{EXCONT } \boxed{2} \\ \text{INCONT } \boxed{1} \; \exists y.([y] \wedge [y]) \\ \text{PARTS } \langle y, \boxed{1}, \boxed{1a}\,[y] \wedge [y], \boxed{2} \rangle \end{bmatrix} \end{bmatrix} \end{bmatrix} \;\&\; \boxed{1} \lhd \boxed{2}$$

　　b.　Part of the lexical entry of *shu*:

$$\begin{bmatrix} word \\ \text{PHON } \langle shu \rangle \\ \text{SL} \begin{bmatrix} \text{CAT HEAD } noun \\ \text{CONT} \begin{bmatrix} \text{EXCONT } \boxed{4} \\ \text{INCONT } \boxed{3} \; \text{book}(\text{Y}) \\ \text{PARTS } \langle \text{Y}, \boxed{3}, \boxed{3a}\,\text{book} \rangle \end{bmatrix} \end{bmatrix} \end{bmatrix} \;\&\; \boxed{3} \lhd \boxed{4}$$

Now, in (11) let us derive the logical form of the NP *yi-ben shu* (*a book*). The semantic composition of the mother NP is guided by several principles (Penn & Richter, 2004). The LRS Projection Principle states that the EXCONT and the INCONT of the mother are identical to their counterparts in the head daughter. Therefore, the EXCONT of the NP is $\boxed{4}$ and the INCONT is $\boxed{3}$. The Semantics Principle (SP) is the other guiding principle to determine each syntactic daughter's semantic contribution. The SP differs depending on the CAT|HEAD of the daughters. For (11), because the non-head is a quantifier and its INCONT is of the form $Qx.(\rho \circ \nu)$, the INCONT of the head ($\boxed{3}$) is a component of ρ. Therefore, the existentially quantified expression is now $\exists y.([\text{book}(y), \text{Y}] \wedge [y])$. Because y is a subexpression of book(y), the expression can be simplified to $\exists y.([\text{book}(y)] \wedge [y])$. Then, the local selection mechanism will bind the free variable Y with the existentially quantified y because that is the only possible binding option. The expression can be rewritten as $\exists y.([\text{book}(y)] \wedge [y])$. The SP for the NP case also states that the INCONT value of the non-head daughter ($\boxed{1}$) is identical with the EXCONT value of the head daughter ($\boxed{4}$). The analysis (12) of the other NP (*mei-ge xuesheng*, *every student*) is analogous.

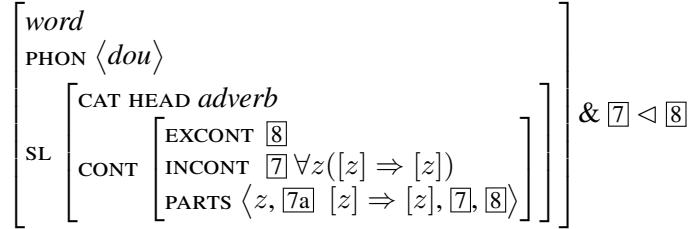(11)　Deriving the logical form of the NP *yi-ben shu* (*a book*):

yi-ben shu

$$
\begin{bmatrix}
\text{CAT HEAD } np \\
\text{CONT} \begin{bmatrix} \text{EXCONT } \boxed{4} \ \ \exists y.([\text{book}(y)] \wedge [y]) \\ \text{INCONT } \boxed{3} \end{bmatrix}
\end{bmatrix} \ \& \ \boxed{1} = \boxed{4}
$$

yi-ben

$$
\begin{bmatrix}
\text{CAT HEAD } clp \\
\text{CONT} \begin{bmatrix} \text{EXCONT } \boxed{2} \\ \text{INCONT } \boxed{1} \end{bmatrix}
\end{bmatrix}
$$

shu

$$
\begin{bmatrix}
\text{CAT HEAD } noun \\
\text{CONT} \begin{bmatrix} \text{EXCONT } \boxed{4} \\ \text{INCONT } \boxed{3} \end{bmatrix}
\end{bmatrix}
$$

(12) The semantic composition of the NP *mei-ge xuesheng* (*every student*):

$$
\begin{bmatrix}
\textit{mei-ge xuesheng} \\
\text{CAT HEAD } np \\
\text{CONT} \begin{bmatrix} \text{EXCONT } \boxed{6} \ \ \forall x.([\text{student}(x)] \wedge [x]) \\ \text{INCONT } \boxed{5} \ \ \text{student}(x) \end{bmatrix}
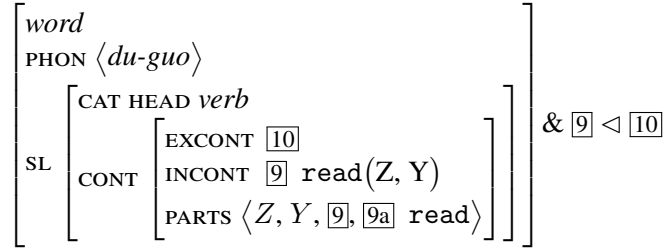\end{bmatrix}
$$
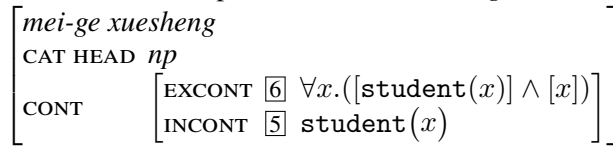
Building Verbal Projections   In (13a), we give the lexical entry of the adverb *dou* and the verb *du-guo* (*read*). The analysis is very similar to the previous analysis of the NP. As we discussed in section 2.3, *dou* possesses a genuinely semantic import and it is inherently universal in (2b). We have reflected that in the lexical entry of *dou* (13a).
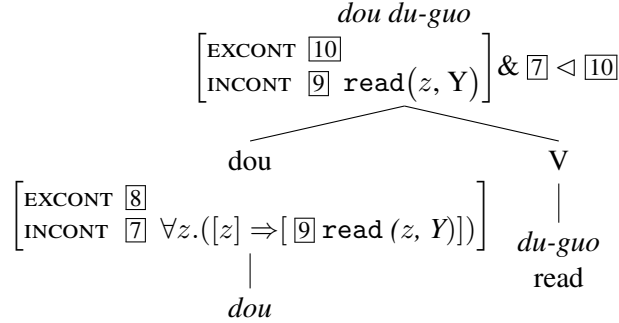
(13)   a.   Part of the lexical entry of *dou*:

$$
\begin{bmatrix}
\textit{word} \\
\text{PHON } \langle dou \rangle \\
\text{SL} \begin{bmatrix} \text{CAT HEAD } \textit{adverb} \\ \text{CONT} \begin{bmatrix} \text{EXCONT } \boxed{8} \\ \text{INCONT } \boxed{7} \ \forall z([z] \Rightarrow [z]) \\ \text{PARTS } \langle z, \boxed{7a} \ [z] \Rightarrow [z], \boxed{7}, \boxed{8} \rangle \end{bmatrix} \end{bmatrix}
\end{bmatrix} \ \& \ \boxed{7} \lhd \boxed{8}
$$

b.   Part of the lexical entry of *du-guo*:

$$
\begin{bmatrix}
\textit{word} \\
\text{PHON } \langle du\text{-}guo \rangle \\
\text{SL} \begin{bmatrix} \text{CAT HEAD } \textit{verb} \\ \text{CONT} \begin{bmatrix} \text{EXCONT } \boxed{10} \\ \text{INCONT } \boxed{9} \ \text{read}(Z, Y) \\ \text{PARTS } \langle Z, Y, \boxed{9}, \boxed{9a} \ \text{read} \rangle \end{bmatrix} \end{bmatrix}
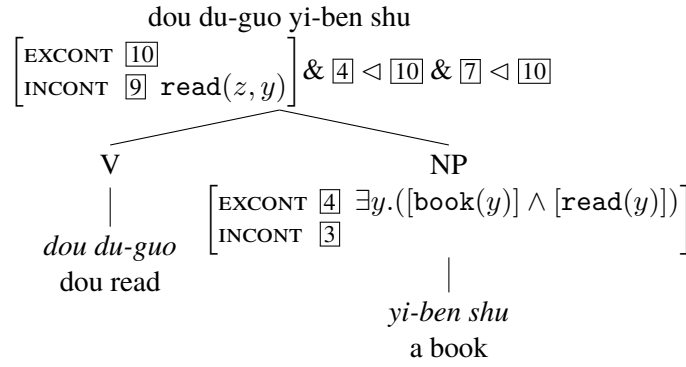\end{bmatrix} \ \& \ \boxed{9} \lhd \boxed{10}
$$

The composition of the VP and the S is also similar to that of the NP (14). The LRS Projection Principle specifies that the INCONT value is $\boxed{9}$ and the EXCONT value is $\boxed{10}$ for both (14a) and (14b). For (14a), the SP specifies that $\boxed{9}$ is a subterm of the implication's consequent. Also, similar to how y binds to the free variable Y in (11), the universally quantified z binds to Z. For (14b), the non-head is a quantified NP with the EXCONT value of the form $Qx.(\rho \circ \nu)$. Therefore, the INCONT value of the head ($\boxed{9}$) is a subexpression of the right-hand conjunct and the free variable Y is bound to y.

111

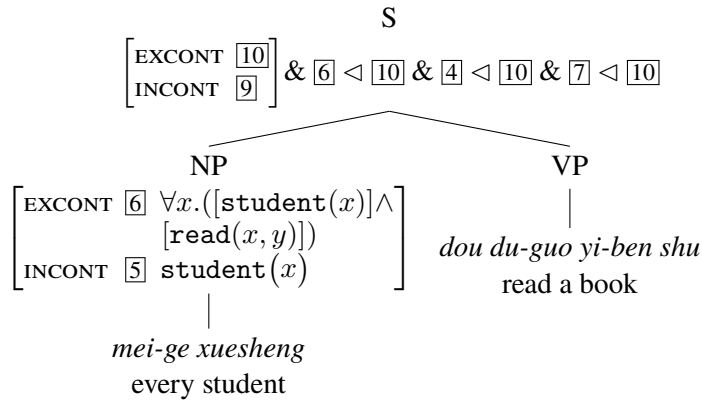(14)   a. Analysis of the adverb *dou* modifying a verb:

$$\text{dou du-guo}$$

$$\begin{bmatrix} \text{EXCONT} & \boxed{10} \\ \text{INCONT} & \boxed{9} \ \texttt{read}(z, \text{Y}) \end{bmatrix} \& \ \boxed{7} \lhd \boxed{10}$$

dou   V

$$\begin{bmatrix} \text{EXCONT} & \boxed{8} \\ \text{INCONT} & \boxed{7} \ \forall z.([z] \Rightarrow [\boxed{9}\ \texttt{read}\ (z, \text{Y})]) \end{bmatrix}$$

| *du-guo*

       read

dou

b. Analysis of the VP *dou du-guo yi-ben shu* (*dou read one book*):

$$\text{dou du-guo yi-ben shu}$$

$$\begin{bmatrix} \text{EXCONT} & \boxed{10} \\ \text{INCONT} & \boxed{9} \ \texttt{read}(z, y) \end{bmatrix} \& \ \boxed{4} \lhd \boxed{10} \ \& \ \boxed{7} \lhd \boxed{10}$$

V   NP

|

dou du-guo $\begin{bmatrix} \text{EXCONT} & \boxed{4} \ \exists y.([\texttt{book}(y)] \wedge [\texttt{read}(y)]) \\ \text{INCONT} & \boxed{3} \end{bmatrix}$

dou read

                            yi-ben shu

                            a book

Finally, the analysis of the whole sentence appears in (15). The non-head is a quantified NP with the EXCONT value of the form $Qx.(\rho \circ \nu)$. Thus, the analysis is the same as in (14).

(15)   Analysis of the sentence:

$$\text{S}$$

$$\begin{bmatrix} \text{EXCONT} & \boxed{10} \\ \text{INCONT} & \boxed{9} \end{bmatrix} \& \ \boxed{6} \lhd \boxed{10} \ \& \ \boxed{4} \lhd \boxed{10} \ \& \ \boxed{7} \lhd \boxed{10}$$

NP   VP

$$\begin{bmatrix} \text{EXCONT} & \boxed{6} \ \forall x.([\texttt{student}(x)] \wedge \\ & \quad [\texttt{read}(x, y)]) \\ \text{INCONT} & \boxed{5} \ \texttt{student}(x) \end{bmatrix}$$

                       dou du-guo yi-ben shu

| read a book

mei-ge xuesheng

every student

5.1   Universal Complexity Constraint

The SP does not impose any conditions on how to resolve the relative scopes of the universal quantifier ($\boxed{4}$) contributed by the subject NP and the universal quantifier contributed by *dou* ($\boxed{7}$). There are therefore three valid combinations (16). The first

two readings differ in which universal quantifier outscopes the other: the quantifier contributed by the subject NP outscoping the quantifier contributed by *dou* (16a), or the other way around (16b).

(16)   a. $\boxed{4} \lhd \boxed{7}$: the EXCONT contains two universal quantifiers.

   b. $\boxed{7} \lhd \boxed{4}$: the EXCONT contains two universal quantifiers.

   c. $\boxed{7} = \boxed{4}$: the EXCONT contains one universal quantifier.

(16a) will yield three possible readings:

- $\forall_1 x.(\text{student}(x) \Rightarrow \forall_2 z.(\exists y.\text{book}(y) \wedge \text{read}(x, y)))$;

- $\forall_1 x.(\text{student}(x) \Rightarrow \exists y.\text{book}(y) \wedge \forall_2 z.(\text{read}(x, y)))$;

- and $\forall_2 z.(\forall_1 x.(\text{student}(x) \Rightarrow \exists y.\text{book}(y) \wedge \text{read}(x, y)))$.

(16b) will yield similar readings with duplicated universal quantifiers. Recall the Polish example *nikt nie przyszedł* (2.3). Among the different ways to resolve the negation contributed by the n-word (*nikt*, *nobody*) and the negation contributed by *nie* (NM) is an undesirable double negation reading of the sentence. To exclude this reading, Richter & Sailer (2004) impose a language-specific constraint for Polish:

(17)   The NEGATION COMPLEXITY CONSTRAINT (NCC):
   For each sign, there may be at most one negation that is a component of the TOP value and has the MAIN value as its component.

Similarly, we want to impose the following language-specific constraint for Chinese:

(18)   The UNIVERSAL COMPLEXITY CONSTRAINT (UCC):
   dou's contribution is *eclipsed* by the contributions of universally quantified QPs that occur before the verb.

The idea of eclipsed operators does exist in LRS in less general forms: in the NCC above, it appears as a cardinality constraint on the number of negations, and in later LRS publications, certain words make reference to logical operators in their semantics that they did not contribute (with the understanding that some other word must have contributed them). Here, we cannot avail ourselves of an absolute cardinality constraint because the number of pre-verbal QPs is theoretically unbounded (19):

(19)   每个　　班　的　每个　　学生　　都　读过　　一本　书
　　　 měi-gè bān dè měi-gè xuéshēng dōu dúguò yī-běn shū
　　　 every-CL class POS every-CL student　DOU read-ASP one-CL book
　　　 Every student from every class read a book.

Furthermore, *dou* does contribute a universal quantifier when there are no pre-verbal QPs (20):

(20) 张三　　李四 王五　　都 读过　　一本 书
　　　 zhāngsān lǐsì　wángwǔ dōu dú-guò　yī-běn shū
　　　 Zhangsan Lisi　Wangwu DOU read-ASP one-CL book
　　　 Zhangsan, Lisi and Wangwu all read a book.

But *dou* does not contribute an additional universal quantifier when there are others that it could be concordant with.

The first two readings (16a, 16b) violate the UCC as the universal quantifier $\forall_1$ is contributed by a QP (*mei-ge xuesheng, every student*), and the other would-be universal quantifier $\forall_2$ is contributed by *dou*.

5.2 Universal Criterion

Richter & Sailer (2004) impose a second language-specific principle to enforce the co-occurrence of *nie* (NM) and n-words:

(21) The NEG CRITERION (NegC):
　　　 For every verb, if there is a negation in the TOP value of the verb that has scope over the MAIN value of the verb, then that negation must be an element of the PARTS list of the verb.

Similarly, we want to enforce the co-occurrence of *dou* and pre-verbal *mei*-NPs by imposing a UNIVERSAL CRITERION.

(22) The UNIVERSAL CRITERION ($\forall$C):
　　　 For an utterance, if there is a universal QP that appears before the verb, the first QP to the left of the verb and the verb must be universally quantified; otherwise, if there are no universal QPs in any preverbal position, the verb must not be universally quantified.

The $\forall$C accounts for our aforementioned data (2). If there is a universal QP before the verb, *dou* is mandatory. Furthermore, if there is no universal quantifier before the verb, no matter whether there are universal quantifiers postverbally, (2a) or not (23), *dou* is not required.

(23) 一个　　学生　　　读过　　一本　书
　　　 yī-gè　xuéshēng dú-guò　yī-běn shū
　　　 one-CL student　read-ASP one-CL book

The $\forall$C can also explain the two examples in (6). For (6a), because the QP *mei-be shu* (*every book*) appears before the verb, *dou* must appear; however, because the first QP to the left of verb is an existential QP, *dou* must not appear. This contradiction explains why (6a) is ungrammatical with or without the presence of *dou*. Nevertheless, if we replace the existential QP with a non-quantifier (in (6b), a proper noun replaces the QP), the first QP to the left of the verb is now the universal quantifier, and (6b) is grammatical with a mandatory *dou*.

5.3 Quantifier Order List

Finally, we account for the scopal asymmetry by introducing a novel QUANTIFIER ORDER LIST. As shown in (25), the QO list records the linear order of the scopal elements — the QO list of the sentence *mei-ge xuesheng dou du-guo yi-ben shu* (*every student dou read a book*) is $\langle \forall, \exists, \forall \rangle$.

(24) The QUANTIFIER ORDER LIST (QO):
The quantifier order list (QO) records the linear order of the scopal elements, with the exception that a pre-verbal quantifier is outscoped by any quantifiers in the object NPs.

(25) QO list composition for sentence (2b) *mei-ge xuesheng dou du-guo yi-ben shu* (*every student dou read a book*):
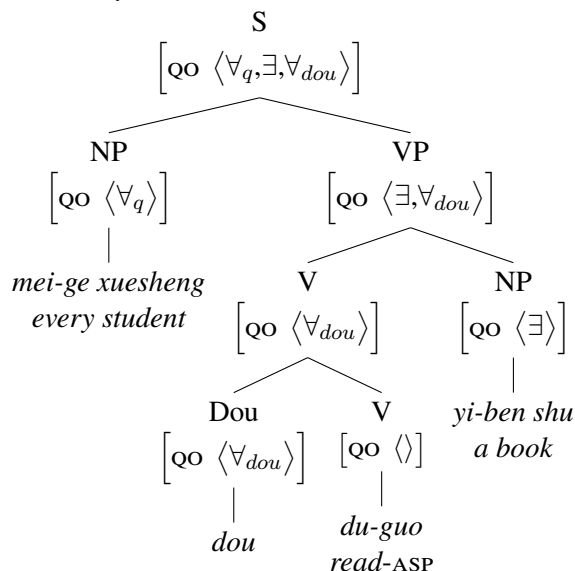
We conjecture that the quantificational scope of a clause in Chinese is determined by this linear ordering. Although we impose the restriction through the UCC that the adverb *dou* does not contribute an additional universal quantifier, the universal quantification can be expressed by either a quantifier or the adverb *dou*, therefore causing a scopal ambiguity. Taking (25) as an example, the sentence is ambiguous because, when the quantifier expresses the universal quantification ($\forall_q$), the sentence will yield a wide universal reading; but when *dou* expresses the universal quantification, and because the quantification of *dou* ($\forall_{dou}$) follows the quantification of the object NP ($\exists$) on the QO list, the sentence will yield the wide existential reading.

(26) The QUANTIFIER ORDER CONSTRAINT (QOC):
The quantifier scope order must be a subsequence of the QO.

This constraint can also be generalised to other examples. For (27a), *dou* is not present in the sentence and the QO list can only be $\langle \exists, \forall \rangle$. Therefore, there is only a

single wide existential reading of the sentence. Unlike (27b), both (27c) and (27d) are not ambiguous despite having a mandatory *dou* in the sentence. This is because the existential quantification precedes both universal quantifications in both of the sentences.

(27) a. yi-ge   xuesheng du-guo   mei-ben shu
         one-CL student   read-ASP every-CL book

      QO: $\langle \exists, \forall \rangle$ readings: $(\exists > \forall)$ $(*\forall > \exists)$

   b. mei-ge   xuesheng dou du-guo   yi-ben shu
      every-CL student   DOU read-ASP one-CL book

      QO: $\langle \forall, \exists, \forall \rangle$ readings: $(\forall > \exists)$ $(\exists > \forall)$

   c. yi-ben shu   mei-ge   xuesheng dou du-guo
      one-CL book every-CL student   DOU read-ASP

      QO: $\langle \exists, \forall, \forall \rangle$ readings: $(\exists > \forall)$ $(*\forall > \exists)$

   d. yi-ge   xuesheng mei-ben shu   dou du-guo
      one-CL student   every-CL book DOU read-ASP

      QO: $\langle \exists, \forall, \forall \rangle$ readings: $(\exists > \forall)$ $(*\forall > \exists)$

5.4   Full Analysis

The full analysis of the sentence (2b) *mei-ge xuesheng dou du-guo yi-ben shu* (*every student dou read a book*) is shown in Figure 1. For logical forms in the parse tree, the curly braces $\{\alpha\}$ contain the internal content, the caret sign $^\wedge\beta$ indicates the external content, the round brackets $()$ change the order of operation, as in arithmetic, and the square brackets again specify subterms that must be contained; $[LF_1, LF_2]$ denotes a term with both LF_1 and LF_1 as subterms.

6   Conclusion

Using a novel concord-based analysis of Chinese quantifier scope, we address some of the limitations of previous work, and reconcile the co-occurrence of *mei* and *dou*. Future research will hopefully use our LRS case study as a starting point to expand on the topic of Chinese quantifier scope. There are many more possible quantifiers than universal and existential. Do they also have a special scope-bearing adverb like *dou*? Is the same concord-based analysis amenable to the other quantifiers? Liu (2021) has also pointed out there are other adverbs such as *ye* (also) and *you* (again) that exhibit a similar distribution to *dou* in that they can all appear preverbally or before predicate adjectives.[2] Can we perform a similar analysis on those adverbs as well? These are all intriguing questions to be answered in relation to the present topic.

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[2]Relative to quantificational *dou*, *ye* and *you* can occur either before or after, with the relative scope being determined by the chosen linear order. Relative to presuppositional *dou*, they must occur after (closer to the predicate).
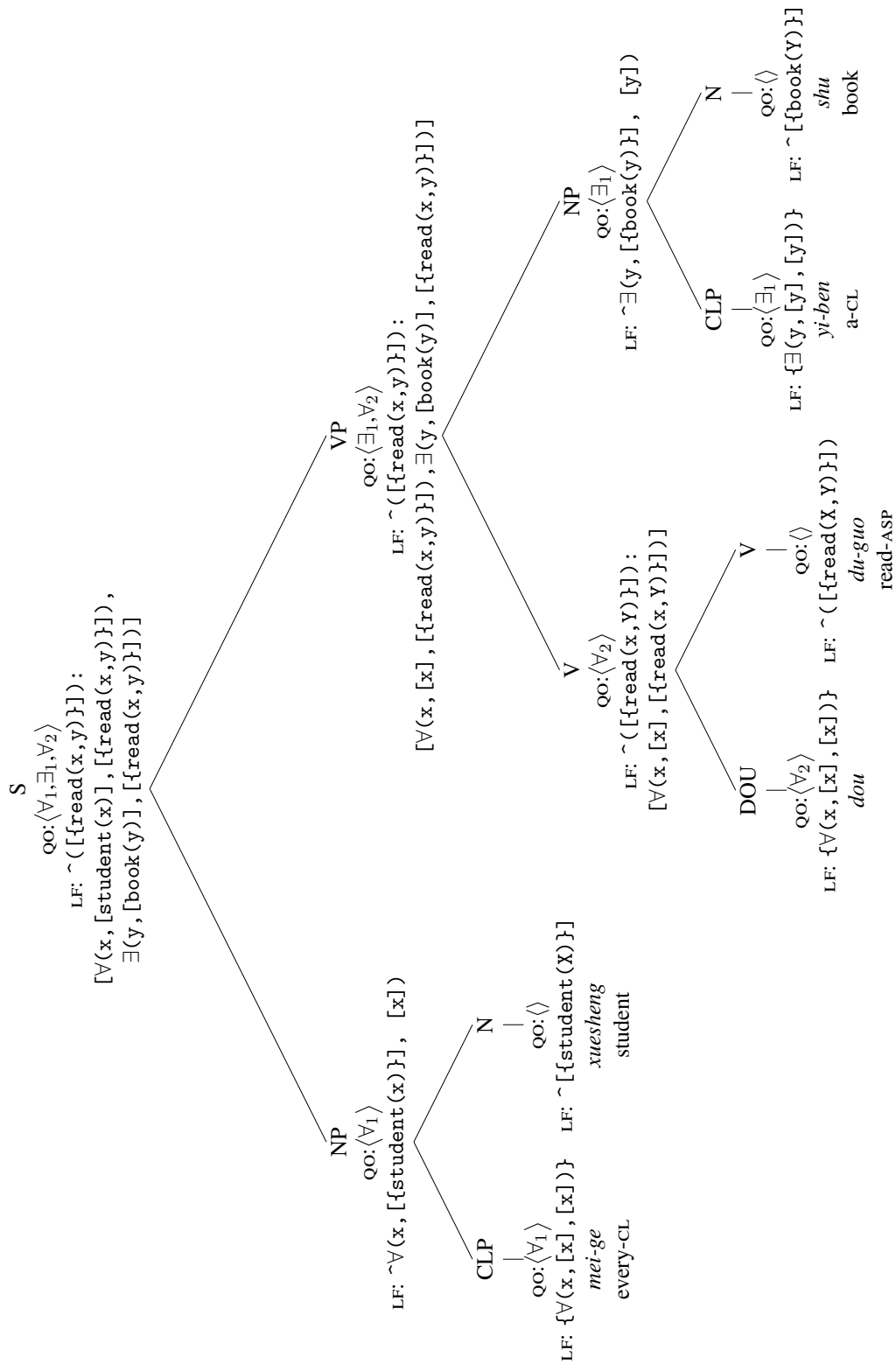
S

QO:⟨∀₁,∃₁,∀∀₂⟩

LF: ^([{read(x,y)}]):
∀(x,[student(x)],[{read(x,y)}]),
∃(y,[book(y)],[{read(x,y)}])]

NP

QO:⟨∀₁⟩

LF: ^∀(x,[{student(x)}], [x])

CLP

QO:⟨∀₁⟩

LF: {∀(x,[x],[x])}

mei-ge
every-CL

N

QO:⟨⟩

LF: ^{{student(X)}}

xuesheng
student

VP

QO:⟨∃₁,∀∀₂⟩

LF: ^([{read(x,y)}]):
∀(x,[x],[{read(x,y)}]),∃(y,[book(y)],[{read(x,y)}])]

V

QO:⟨∀∀₂⟩

LF: ^([{read(x,y)}]):
∀(x,[x],[{read(x,y)}])]

DOU

QO:⟨∀∀₂⟩

LF: {∀(x,[x],[x])}

dou

V

QO:⟨⟩

LF: ^([{read(X,Y)}])

du-guo
read-ASP

NP

QO:⟨∃₁⟩

LF: ^∃(y,[{book(y)}], [y])

CLP

QO:⟨∃₁⟩

LF: {∃(y,[y],[y])}

yi-ben
a-CL

N

QO:⟨⟩

LF: ^{{book(Y)}}

shu
book

Figure 1: LRS analysis of (2b) *mei-ge xuesheng dou du-guo yi-ben shu (every student dou read a book)*.

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Acknowledgements

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