Dou and plural universal quantification in Mandarin Chinese

Introduction. Mandarin Chinese uses a combination of *mei* and *dou* to express universal quantification. In most cases, *dou* is obligatory as in (1).

Like *every*, *mei* can be used with numerals larger than one, in which case *dou* is no longer always obligatory. Suppose there are 4 students in the context for (2) and (3).

(1) **mei** yi-ge xuesheng *(**dou**) hui shuo yingyu.
every 1-CL student DOU can speak English
'Every student can speak English.'

With *dou*, as in (2), 'mei-*n*-NP dou VP' quantifies over every possible *n*-sized plurality. As $n = 2$, $\binom{4}{2} = \frac{4 \cdot 3}{2 \cdot 1} = 6$ pluralities are quantified over. I call this the **exhaustive** reading.

(2) **mei** liang-ge xuesheng *(**dou**) xie-le yi-pian lunwen.
every 2-CL student DOU wrote 1-CL paper
'Every possible pair of students wrote a paper together.'
⇒ 6 papers written

Without *dou*, as in (3), 'mei-*n*-NP VP' is only licensed when VP contains an indefinite numeral. A partition of the domain into *n*-sized pluralities is quantified over; there are $\frac{4}{2} = 2$ pluralities. I call this the **partition** reading.

(3) **mei** liang-ge xuesheng (***dou**) xie-le yi-pian lunwen.
every 2-CL student DOU wrote 1-CL paper
'Every pair in a partition of the students into pairs wrote a paper together.'
⇒ 2 papers written

What is the semantic contribution of dou*? Why is it* obligatory *in **exhaustive** but* impossible *in **partition**?*

Proposal. I argue that the account of *dou* as equivalent to English *even* in Liu (2021) explains the alternation between exhaustive and partition readings with and without *dou* if we accommodate the general ambiguity of plural universals between exhaustive and partition readings through domain variables and adopt a revised understanding of domain alternatives that *even*/*dou* quantifies over.

Liu (2021) on *mei-dou* co-occurrence. Liu (2021) treats *dou* just like English *even*:

(4) $[\![\text{dou}_C\ S]\!]$ is defined iff $\forall q \in \{[\![S']\!] \mid S' \in \text{ALT}(S)\} \cap C.\ [\![S]\!] \neq q \rightarrow [\![S]\!] \prec q$. If defined, $[\![\text{dou}\ S]\!] = [\![S]\!]$.

It presupposes that the prejacent is the *strongest* w.r.t an ordering on propositions ($\prec$) among its alternatives and asserts the prejacent if the presupposition is satisfied. Notice that although *dou* is clause-medial, it moves covertly to a high position to take the entire clause as its argument, enabling the definition in (4).

Mei is just a regular universal quantifier as in (5).

(5) $[\![\text{mei}_D]\!] = \lambda P.\ \lambda Q.\ \forall x. x \in D \wedge P(x) \rightarrow Q(x)$

The associate of *dou* is the domain variable D on *mei*, supposedly students $\{\mathbf{a}, \mathbf{b}, \mathbf{c}\}$ as in (6); the alternatives are the domain alternatives (7), which in this case are all necessarily subdomains:

(6) mei$_D$ yi-ge xuesheng *(dou) lai-le.
every 1-CL student DOU came
$\underline{\forall x \in \{\mathbf{a}, \mathbf{b}, \mathbf{c}\}.\ \mathsf{came}(x)}$

(7) $\forall x \in \{\mathbf{a}\}.\ \mathsf{c}(x), \forall x \in \{\mathbf{b}\}.\ \mathsf{c}(x), \forall x \in \{\mathbf{c}\}.\ \mathsf{c}(x)$,
$\forall x \in \{\mathbf{a}, \mathbf{b}\}.\ \mathsf{c}(x), \forall x \in \{\mathbf{b}, \mathbf{c}\}.\ \mathsf{c}(x), \forall x \in \{\mathbf{c}, \mathbf{a}\}.\ \mathsf{c}(x)$,
$\underline{\forall x \in \{\mathbf{a}, \mathbf{b}, \mathbf{c}\}.\ \mathsf{c}(x)}$

The alternatives are all entailed by the prejacent, which is therefore the *strongest* w.r.t entailment. The presupposition is satisfied, and the meaning of (6) is just 'every student came.' Then, the following principle (8) derives the obligatoriness of *dou* for (6), akin to the obligatoriness of *also* and *too* in certain contexts:

(8) *Maximize Presupposition* (MP): Make your contribution presuppose as much as possible (Heim, 1991).

Since the presupposition of *dou* in (7) is met, its use is obligatory with 'mei-1-NP,' as there are no particles with stronger presuppositions.

Explaining the alternation with and without *dou*. Liu (2021) can be extended with two observations to account for the alternation between exhaustive and partition readings with and without *dou*.

First, plural universal quantifiers are inherently ambiguous between the exhaustive and partition readings. This is seen in the English examples with *every*; (9) and (10) are paired with their most salient interpretations:

(9) Every two students shook hands.
⇒ all possible pairs, $\binom{n}{2}$ handshaking events

(10) Every two students wrote a paper together.
⇒ pairs in a partition, $\frac{n}{2}$ papers written

This ambiguity can be captured through the domain variables on the universal quantifiers as in (11), (12):

(11) *Exhaustive reading*
D_{exh} is the closure under $\oplus$ of the set of contextually salient atoms in $[\![\text{NP}]\!]$ (Crnič, 2022).

(12) *Partition reading*
D_{part} is different from D_{exh} in that the *n*-sized pluralities form a partition of $\bigoplus D_{\text{exh}}$.

Second, the restriction that domain alternatives are only subdomain alternatives (implicit in Liu 2021; Crnič 2022) should be relaxed. It is just that when the domain is the closure under $\oplus$ of the contextually salient atoms, no larger domain can possibly be constructed. In principle, given a domain D, as long as $\bigoplus D' \sqsubseteq \bigoplus D$ (so D' does not involve atoms not involved in D), D' should be a domain alternative of D even if $D' \nsubseteq D$. *This formulation makes D_{exh} and D_{part} each other's alternatives since they involve the same atoms.*
Then, the obligatory presence and obligatory absence of *dou* with the exhaustive and partition readings respectively are easily derivable: *dou*'s presupposition is met in the former but not in the latter. I assume (13)–(16) for *mei*, *n*-CL NP, and the domains involved:

(13) $[\![\text{mei}_D]\!] = \lambda P : |D \cap P| \geq 2.\, \lambda Q.\, \forall x \in D \cap P.\, Q(x)$ (14) $[\![n\text{-CL NP}]\!] = \lambda X.\, |X| = n \wedge X \in *[\![\text{NP}]\!]$

(15) Domain of 'mei-*n*-NP' with *dou*: D_{exh} (16) Domain of 'mei-*n*-NP' without *dou*: D_{part}

Then, we can look at (17) and (18); suppose the atomic students in the context are **a**, **b**, **c**, **d**,

(17) mei$_{D_{\text{exh}}}$ 2 student *(dou) wrote a paper together.
$\forall X \in D_{\text{exh}} \cap [\![\text{two students}]\!] = \{\mathbf{a} \oplus \mathbf{b}, \mathbf{a} \oplus \mathbf{c}, \mathbf{a} \oplus \mathbf{d}, \mathbf{b} \oplus \mathbf{c}, \mathbf{b} \oplus \mathbf{d}, \mathbf{c} \oplus \mathbf{d}\}.\, \mathsf{write.paper}(X)$ $\Rightarrow$ 6 papers

(18) mei$_{D_{\text{part}}}$ 2 student (*dou) wrote a paper together.
$\forall X \in D_{\text{part}} \cap [\![\text{two students}]\!] = \{\mathbf{a} \oplus \mathbf{b}, \mathbf{c} \oplus \mathbf{d}\}.\, \mathsf{write.paper}(X)$ $\Rightarrow$ 2 papers

When $n \geq 2$, as $|D \cap P| \geq 2$, we have $D_{\text{part}} \subset D_{\text{exh}}$. In (17), D_{exh} is the maximal domain, so the prejacent entails all its alternatives; *dou* is obligatory by MP. In (18), D_{part} is not maximal, so the prejacent doesn't entail all the alternatives (e.g., the prejacent of (17)) and is therefore not the strongest among the alternatives; the presupposition of *dou* is not met and its presence is impossible.
When $n = 1$, $D_{\text{exh}} = D_{\text{part}}$; as these domains are equally maximal, *dou* is generally always obligatory, which is just the result with singular universal quantification seen in Liu (2021).

Extension to plural free choice (FC) indefinites. The present approach predicts that when an element requiring that the prejacent be the strongest among the alternatives (*dou*, *even*) is present, the sentence, if expressing a universal proposition, should have the maximal domain. Following Lahiri (1998); Crnič (2017, 2022), 'NPIs are weak elements that are associates of *even*,' the prediction becomes that when an NPI indefinite under a universal FC reading involves a numeral $n \geq 2$, it is always the **exhaustive** rather than the **partition** reading. This prediction is borne out. Suppose the domain variable on *any D* is D_{part} in (19).

(19) $\emptyset_{\text{even}}$ [exh$_R$ any$_D$ two students can write a paper together].

By *Innocent Inclusion* in Bar-Lev and Fox (2020), (19) can have the meaning that all and only the pluralities in a partition of contextually salient students into pairs can co-author a paper (**partition**). However, (19) clearly doesn't have this meaning; rather, it must mean that all possible pairs of students can co-author a paper (**exhaustive**). This is because $\emptyset_{\text{even}}$'s presupposition isn't satisfied when $D = D_{\text{part}}$ in (19) since replacing D_{part} with D_{exh} will result in a stronger alternative. D can only be D_{exh} in the presence of $\emptyset_{\text{even}}$.

The same is true in Chinese; NPI *renhe* 'any' also forces the presence of *dou* which forces the use of D_{exh} in (20).

(20) **renhe** liang-ge xuesheng *(**dou**) keyi xie yi-pian lunwen.
any 2-CL student DOU can write 1-CL paper
'Any two students can write a paper (together).'

(20) can only mean that all possible pairs of students can co-author a paper, not just pairs in a partition. This connection between plural universals and plural FC indefinites cannot be captured by analyses of *dou* without an *even*-like semantics, e.g. Sun (2018), who considers *dou* a plain universal quantifier and posits that there is a covert *dou* imposing the partition requirement and used in the partition reading instead of overt *dou*.

Conclusion. The account of *mei-dou* occurrence in Liu (2021), as long as we relax the requirement on domain alternatives to accommodate the ambiguity of plural universal quantification between exhaustive and partition readings, can account for the alternation with and without *dou* between the exhaustive and partition readings of 'mei-*n*-NP' constructions. The account also extends to universal FC plural NPIs, where the obligatory presence of *even* or *dou* forces an exhaustive reading.

• Bar-Lev, Moshe E., and Danny Fox. 2020. Free choice, simplification, and Innocent Inclusion. *Natural Language Semantics* 28:175–223. • Crnič, Luka. 2017. Free Choice under Ellipsis. *The Linguistic Review* 34:249–294. • Crnič, Luka. 2022. Number in NPI licensing. *Natural Language Semantics* 30:1–46. • Heim, Irene. 1991. Artikel und definitheit. In *Semantik: Ein internationales Handbuch der zeitgenssischen Forschung*, 487–535. Berlin: de Gruyter. • Lahiri, Utpal. 1998. Focus and Negative Polarity in Hindi. *Natural Language Semantics* 6:57–123. • Liu, Mingming. 2021. A pragmatic explanation of the *mei-dou* co-occurrence in Mandarin. *Journal of East Asian Linguistics* 30:277–316. • Sun, Yenan. 2018. Two kinds of quantificational domains: Mandarin *mei* with or without *dou*. In *Proceedings of the 53rd Annual Meeting of the Chicago Linguistic Society*.