Mandarin particle *dou*: A pre-exhaustification exhaustifier[1]

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1. Introduction

- This paper presents a uniform semantics to capture the seemingly diverse functions of the Mandarin particle *dou*: quantifier-distributor, free choice item (FCI)-licenser, scalar marker, ...

1. Quantifier/distributor:

In a basic declarative, *dou* universally quantifies over the subparts of the denotation of the associated item (enclosed in "[●]").

(1) [Tamen] **dou** dao -le.
they DOU arrive -ASP
'They all arrived.'

Under this use, *dou* brings up more semantic consequences than ∀-quantification. Descriptively:

"Distributivity Requirement": if the prejacent sentence admits both collective and (atomic/non-atomic) distributive readings, applying *dou* **eliminates the collective reading** (Lin 1996).

(2) [Yuehan he Mali] **dou** jiehun -le.
John and Mary DOU get-married -ASP
'John and Mary each got married.'

(3) [Tamen] **dou** mai-le fangzi.
they dou buy-Perf house
'They all bought houses.'(#collective)

"Plurality Requirement": the item associated with *dou*, overt or covert, must be **non-singular**.

(4) Yuehan [(mei-ci)] **dou** qu Beijing.
John every-time DOU go Beijing
'For all the times, the place that John went to was Beijing.'

2. Scalar marker:

A [*lian...dou...*] construction evokes an *even*-like inference: the prejacent proposition is less likely than (some of) its alternatives. The use of *lian* is optional, but the associated item must be stressed.

(5) (Lian) [LINGDAO]$_F$ **dou** chi dao -le.
even leader DOU late arrive -ASP
'Even the leader was late.' ⇝ The leader is less likely to be late.

When associated with a scalar item (usually stressed), *dou* implies that the prejacent sentence ranks relatively high w.r.t the contextually relevant measurement.

(6) **Dou** [WU dian]$_F$ -le.
DOU five o'clock -ASP.
'It is **dou** five o'clock.' ⇝ It's too late.

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3. FCI-licenser:

When associated with a pre-verbal *wh*-item/disjunction, *dou* evokes a ∀-FC reading.

(7) [Shei] *(**dou**) hejiu.
Who$_{FCI}$ DOU drink
'Anyone/everyone drinks.'

(8) [Yuehan huozhe Mali] dou keyi jiao jichu hanyu.
John or Mary DOU can teach Intro Chinese
Intended: 'Both John and Mary can teach Intro Chinese.'

The licensing of the ∀-FCI use of a pre-verbal disjunction is subject to Modal Obviation: it is only licensed in a pre-*dou*+$\Diamond$ position.

(8′) [Yuehan huozhe Mali] **dou** *(keyi)/*bixu jiao jichu hanyu.
John or Mary DOU can/must teach intro Chinese
Intended: 'Both John and Mary can teach Intro Chinese.'

- **Disambiguation by focus:** If a sentence has multiple items that are eligible to be associated with *dou*, the function of *dou* and the association relation can be disambiguated by stress.

(9) a. [Tamen] **DOU**/**dou** lai -guo liang-ci -le.
they DOU/DOU come -EXP two-time -ASP
'They ALL have been here twice.'

b. Tamen **dou** lai -guo [LIANG$_F$-ci] -le.
they DOU come -EXP two-time -ASP
'They've been here twice.' ⇝ They've been here many times.

c. (Lian) [TAMEN]$_F$ **dou** lai -guo liang-ci -le.
LIAN they DOU come -EXP two-time -ASP
'Even THEY have been here twice.'

- **Overview**

I propose that *dou* is a special exhaustivity operator, which (i) operates on pre-exhaustified sub-alternatives, and (ii) presupposes the existence of a sub-alternative. Descriptively:

(10) $[\![\textbf{dou}(\text{S}_A)]\!]$ (S is the prejacent clause, A is the associated item)
$\approx \textbf{S}_A$ and not only $\textbf{S}_{A'}$ (A' is a subpart/ weak scale-mate/ sub domain-alt/ ... of A, ...)

E.g. "[A and B] **dou** came" means: A and B came, not only A came, and not only B came.
"**dou** [it is five o'clock]" means: It's 5 o'clock, not just 4 o'clock, not just 3 o'clock, ...

Roadmap

- Section 2: Previous approaches
- Section 3: Defining *dou* as a special exhaustifier
- Section 4: ∀-quantifier/distributor
- Section 5: FCI-licenser
- Section 6: Scalar marker
- Section 7: Sorting the parameters: logical strength vs. likelihood
- Appendix: Alternative approaches in the realm of exhaustifications

2. Previous approaches

2.1. The distributor analysis (Lin 1998)

- *Dou* is a generalized distributor PART (Schwarzschild 1996). It distributes over the contextually determined cover of the associated item.

(11) $[\![dou]\!](P, X) = 1$ iff $\text{Part}_C(P, X) = 1$
iff $\forall y[C(y) \wedge y \leq X \rightarrow P(y)]$, where C is a cover of X.

(12) C is a cover of X iff
(i) C is a set of subparts of X; and (ii) every subpart of X is a subpart of some member in C.

> For example: (3) "abc **dou** bought houses."
> The possible covers of abc are:
>
> | | | |
> |---|---|---|
> | $\{a, b, c\}$ | Atomic distributive | 'abc each bought houses' |
> | $\{a \oplus b, c\}$
$\{a \oplus b, b \oplus c\}$
... | Non-atomic distributive | |
> | $\{a \oplus b \oplus c\}$ | Collective | 'abc together bought houses' |

– Problems:

1. Unlike the generalized distributor, *dou* eliminates a single-cover/collective reading (Xiang 2008).

   (3′) abc **dou** bought houses.
   (# w: abc all only participated in a single house-buying event.)

2. Unlike English distributors like *each* and *all*, *dou* can be associated with a distributive expression like NP-*gezi* 'NP each'.

   (13) They each (*each/*all) has some advantages.

   (14) [Tamen] gezi **dou** you yixie youdian.
   They each DOU have some advantage
   'They each **dou** has some advantages.'

3. This analysis cannot be extended to other uses of *dou*.

2.2. The maximality operator analysis (Cheng & Giannakidou 2006, Xiang 2008)

- *Dou* is a maximality operator ($\approx$ *the*) with a plural presupposition; it operates on a set that has been partitioned by covers and picks out the maximal plural individual.

(15) $[\![dou]\!](X) = |C| > 1 \wedge \exists y \in C[\neg Atom(y) \wedge \forall z \in C[z \leq y]]$.
$\iota y \in C[\neg Atom(y) \wedge \forall z \in C[z \leq y]]$ where C is the cover of X
($[\![dou]\!](X)$ is defined iff the cover of X is non-singleton and has a unique non-atomic maximal element; when defined, the reference of $[\![dou]\!](x)$ is this maximal element.)

– Problems:

1. It predicts no distributivity effect. Prediction: "abc dou bought houses" asserts that 'the maximal element in Cov_{abc} bought houses', not that 'every element in Cov_{abc} bought houses'.
2. The plurality requirement comes as a stipulation on the presupposition of *dou*: *dou* presupposes that the selected maximal element is non-atomic.

3. Defining *dou* as a special exhaustifier

3.1. The canonical exhaustifier *only*

- *Only* operates on **excludable** (excl)-alternatives and presupposes the existence of an excl-alternative.

(16) a. $[\![only]\!](p) = \lambda w[p(w) = 1 \wedge \boxed{\exists q \in \textit{Excl}(p)}.\forall q \in \textit{Excl}(p)[q(w) = 0]]$
($[\![only]\!](p)$ is defined iff p is true and p has some excl-alternative(s); when defined, $[\![only]\!](p)$ is true iff the excl-alternatives of p are false.)
b. $\textit{Excl}(p) = \{q : q \in \textit{Alt}(p) \wedge p \not\subseteq q\}$
(The set of alternatives that are not entailed by the prejacent)

Illustrating the additive presupposition: *only* is odd in (17b) because the prejacent is the strongest among the alternatives.

(17) Which of John and Mary will you invite?
a. Only JOHN$_F$, (not Mary / not both).
b. # Only BOTH$_F$.
c. BOTH$_F$.

3.2. Defining *dou* in analogous to *only*

- In analogous, *dou* operates on pre-exhaustified **sub-alternatives** and presupposes the existence of a sub-alternative. Sub-alternatives are complements of excl-alternatives. Pre-exhaustification effect is realized by applying an O-operator to each sub-alternative.

(18) a. $[\![dou]\!](p) = \lambda w[\boxed{\exists q \in \textit{Sub}(p)}.p(w) = 1 \wedge \forall q \in \textit{Sub}(p)[O(q)(w) = 0]]$
($[\![dou]\!](p)$ is defined iff p has at least one sub-alternative; when defined, $[\![dou]\!](p)$ is true iff p is true and **the exhaustification of each sub-alternative** of p is false.)
b. $\textit{Sub}(p) = (\textit{Alt}(p) - \textit{Excl}(p)) - \{p\}$ (To be revised)
(The set of alternatives that are not excludable and distinct from the prejacent)
(= The set of alternatives that are weaker than the prejacent)
c. $O(p) = \lambda w[p(w) = 1 \wedge \forall q[q(w) = 1 \rightarrow p \subseteq q]]$ (Chierchia et al. 2012)

A toy example: The anti-exhaustification condition (underlined) is entailed by the prejacent.

(19) [a and b] **dou** came.
a. $\textit{Alt}(a \oplus b) = D_e$
b. $[\![S]\!] = \text{came}'(a \oplus b)$
c. $\textit{Alt}(S) = \{\text{came}'(x) : x \in D_e\}$
d. $\textit{Sub}(S) = \{\text{came}'(a), \text{came}'(b)\}$
e. $[\![\textit{dou}(S)]\!] = \text{came}'(a \oplus b) \wedge \underline{\neg O[\text{came}'(a)] \wedge \neg O[\text{came}'(b)]}$

(20) [John] (***dou**) came. (ungrammatical unless *John* is stressed)
a. $[\![S]\!] = \text{came}'(j)$
b. $\textit{Sub}(S) = \varnothing$
c. $[\![\textit{dou}(S)]\!]$ is undefined

4. Predicting the quantifier-distributor use

- I argue that the requirements of maximality and plurality are illusions. All the facts that are thought to result from these two requirements actually result from the presupposition of *dou*.

4.1. Deriving the "distributivity requirement"

- In (21), under a single-cover/collective reading, no alternative is asymmetrically entailed by the prejacent and no sub-alternative is available, making the use of *dou* undefined.[2]

(21) 'abc **dou** bought houses.'

a. $p = \text{Part}_{Cov}(f, a \oplus b \oplus c)$

b. $Alt(p) = \{\text{Part}_C(f, X) : X \in D_e\}$

c. **Atomic distributive** $\surd$

If $C = \{a, b, c\}$, then: $Sub(p) = \left\{ \begin{array}{l} \text{Part}_C(f, a), \text{Part}_C(f, b), \text{Part}_C(f, c) \\ \text{Part}_C(f, a \oplus b), \text{Part}_C(f, a \oplus c), \text{Part}_C(f, b \oplus c) \end{array} \right\}$

$= \left\{ \begin{array}{l} f(a), f(b), f(c) \\ f(a) \wedge f(b), f(a) \wedge f(c), f(b) \wedge f(c) \end{array} \right\}$

Non-atomic distributive $\surd$

If $C = \{a, b \oplus c\}$, then: $Sub(p) = \{\text{Part}_C(f, a), \text{Part}_C(f, b \oplus c)\} = \{f(a), f(b \oplus c)\}$

Collective $\times$

If $C = \{a \oplus b \oplus c\}$, then: $Sub(p) = \varnothing$

d. $Sub(p) = \{\text{Part}_C(f, X) : X \in D_e \wedge \{y : y \leq X \wedge C(y)\} \subset C\}$,
where C is the contextually determined cover of $a \oplus b \oplus c$.

– *Dou* can be applied to a collective statement as long as this collective predicate is divisive.

(22) P is divisive iff $\forall x[P(x) \rightarrow \exists y < x[P(y)]]$
(Whenever P holds of something x, it also holds of some proper subpart(s) of x.)

(23) 'abc **dou** are friends.'

a. $Sub(abc$ **are friends**$) = \{ab$ **are friends**, bc **are friends**, ac **are friends**$\}$

b. 'abc **dou** are friends' means: abc are friends, not only ab are friends, not only bc are ...

In contrast, *dou* cannot be applied to a collective statement if the predicate is not divisive.

(24) Tamen (***dou**) zucheng -le zhe-ge weiyuanhui
they DOU form -ASP this committee
'They (*all) formed this committee. '

[2]In the alternatives, C constantly denotes the contextually determined cover of the associated item in the prejacent (viz. the cover of $a \oplus b \oplus c$), and PART only distributes over C. (See Liao 2012: ch. 4.) For example, if $C = \{a, b, c\}$, the alternative $\text{Part}_C(f, d)$ is vacuously a tautology, and the alternative $\text{Part}_C(f, a \oplus b \oplus c \oplus d)$ is logically equivalent to $\text{Part}_C(f, a \oplus b \oplus c)$.
These consequences are fine for now. Nevertheless, problems arise in case that we want an operator to operate on excl-alternatives. For example, to derive the exhaustification inference of (1), 'b bought houses' shall not be a tautology.

(1) Only abc_F bought houses. $\rightsquigarrow$ d didn't bought houses.

See a solution in Liu (2016) based on Link-Landman's approach of encoding distributivity/collectivity distinction.

4.2. Deriving the "plurality requirement"

- This plurality is illusive; it is neither necessary nor sufficient.

– Unnecessary: *dou* can be associated with an atomic element as long as the predicate is divisive.

(25) Yuehan ba [na-ping shei] **dou** he -le (*yi-ban).
John BA that-bottle water DOU drink -ASP one-half

a. $\surd$'J had that bottle of water.' $\Rightarrow$ If x is part of that bottle of water, J had x.
$\mathit{Sub}(\textbf{J had that bottle of water}) = \{\textbf{J had } x : x < \textbf{that bottle of water}\}$

b. $\times$'J had half of that bottle of water.' $\not\Rightarrow$ If x is part of that bottle of water, J had half of x.
$\mathit{Sub}(\textbf{John had half of that bottle of water}) = \emptyset$

– Insufficient: when applied to a statement with a **divisive** collective predicate, *dou* requires its associated item to denote a group containing at least 3 members. This is so because collective predicates are undefined for proper subparts of a dual-individual (i.e. atomics).

(26) 'ab (*dou) are friends.'

a. $[\![\text{are friends}]\!] = \lambda x[\neg \mathit{Atom}(x).\textbf{be-friends}(x)]$

b. $\mathit{Sub}(ab\ \textbf{are friends}) = \varnothing$

5. FCI-licenser use

5.1. Licensing conditions of Mandarin FCIs

- The English polarity item *any* is licensed as a ∀-FCI when appearing over a possibility modal, but not when it appears in an episodic statement or over a necessity modal.

(27)
a.	* Anyone came in.	Episodic statements
b.	Anyone can come in. ≈ Everyone can come in.	Over possibility modals
c.	* Anyone must come in.	Over necessity modals

- In Mandarin, the ∀-FCI use of a disjunction is only licensed in a pre-*dou*+◇ position.

(28) [Yuehan huozhe Mali] **dou** *(keyi)/*bixu jiao jichu hanyu.
John or Mary DOU can/must teach intro Chinese
Intended: 'Both John and Mary can teach Intro Chinese.'

But the ∀-FCI use of a bare *wh*-word can be licensed without a modal. (Giannakidou & Cheng 2006)[3]

(29) [Shei] *(**dou**) dao -le.
who_{FCI} DOU arrive -ASP.
'Everyone arrived.'

The licensing conditions for *na*-CL-NP 'which-NP' and *renhe*-NP 'any-NP' are less clear. They can be licensed in a pre-*dou*+◇ position. Judgements for other contexts vary a lot.

[3] There are, however, variations with this judgement.

5.2. Deriving the ∀-FC inferences

- *Wh*-items are existential indefinites; thus the plain meaning of (29) is equivalent to a disjunction. Sub-alternatives of a disjunction are the disjuncts. Applying **dou** yields a ∀-FC implicature.[4]

(29′) "Shei **dou** arrived."

a. $[\![\text{shei arrived}]\!] = f(a) \vee f(b)$

b. $Sub(\textbf{shei arrived}) = \{f(a), f(b)\}$

c. $[\![\textbf{dou [shei arrived]}]\!] = [f(a) \vee f(b)] \wedge \neg O f(a) \wedge \neg O f(b)$
$= [f(a) \vee f(b)] \wedge [f(a) \rightarrow f(b)] \wedge [f(b) \rightarrow f(a)]$
$= f(a) \wedge f(b)$

! **Problem:** Disjuncts are stronger than a disjunction, how can they be considered as sub-alternatives?

Solution: sub-alternatives are the complements of "innocently (I)-excludable" alternatives.

(30) a. **Sub-alternatives**
$Sub(p) = (Alt(p) - IExcl(p)) - \{p\}$
(The set of alternatives excluding the I-excludable alternatives and the prejacent itself)

b. **Innocently (I)-excl-alternatives** (Fox 2007)[5]
$IExcl(p) = \bigcap\{A : A$ is a maximal subset of $Alt(p)$ s.t. $A^{\neg} \cup \{p\}$ is consistent},
where $A^{\neg} = \{\neg q : q \in A\}$
(q is I-excludable to p iff q is included in every maximal set of alternatives of p s.t. the exclusion of this set is consistent with p.)

- Disjuncts are not I-excludable:

  $\{p \vee q\}$ is inconsistent with $\{p, q\}^{\neg}$: $[p \vee q] \wedge \neg p \wedge \neg q = \bot$

- Non-excludable alternatives are also not I-excludable. Hence, this revision doesn't change the derivation of the quantifier-distributor use of *dou*.

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[4] This derivation looks very close to that of applying Fox's (2007) recursive exhaustifier O_R or Chierchia's (2013) pre-exhaustification operator $O_{\text{D-EXH}}$. But *dou* is not exactly $O_R/O_{\text{D-EXH}}$. First, unlike O_R, *dou* does not negate the I-excludable alternatives and hence doesn't yield an exhaustification inference. Second, while $O_{\text{D-EXH}}$ operates on domain alternatives, which are grammatically defined, *dou* operates on sub-alternatives, which are defined purely semantically. See Xiang (2016: §2.7) for more details.

[5] Another commonly seen definition of I-excl-alternatives is (1), which, however, is inadequate.

(1) $IExcl(p) = \{q : q \in Alt(p) \wedge \underline{\neg\exists q' \in Excl(p)[[p \wedge \neg q] \rightarrow q']}\}$
(The set of alternatives p such that affirming p and negating q does not entail any excl-alternatives)

For example, in (2), where the prejacent is the strongest among the alternatives and thus has no excl-alternative, the condition underlined in (1) is vacuously satisfied; therefore, definition (1) predicts that every alternative of p is I-excludable.

(2) EVERY student came.

5.3. Explaining other licensing conditions

- **In licensing the FCI use of a pre-verbal *wh*-word, the use of *dou* is mandatory.**

  When a *wh*-word has a non-interrogative use, its sub-alternatives are obligatorily activated and must be used by a c-commanding exhaustifier. (Liao 2012, Chierchia & Liao 2015) When *dou* is absent, these sub-alternatives would have to be used by a basic O-exhaustifier,[6] yielding a contradiction:

  (31) $[\![O\ [\textbf{shei arrived}]]\!] = O[f(a) \vee f(b)]$
  $= [f(a) \vee f(b)] \wedge \neg f(a) \wedge \neg f(b)$
  $= \bot$

- **Modal Obviation: licensing the ∀-FCI use of a pre-verbal disjunction needs a weak modal.**

  A focused disjunction obligatorily triggers a scalar implicature (SI).

  In a non-modalized context, the ∀-FC implicature clearly contradicts the SI, therefore FC-disjunctions are not licensed in episodic statements. (Same as Chierchia 2013 on English *any*.)

  ∀-FC: $f(j) \wedge f(m)$ SI: $\neg[f(j) \wedge f(m)]$

  In a modalized context, the SI restricts the modal base M to the set of worlds where the SI is true.[7]

  (32) [John or Mary] **dou** can teach Intro Chinese.
  ⇝ We are only considered with cases where only one person will teach IC.
  ⇝̸ Not that both John and Mary will teach IC.
  a. SI pre-restricts the modal base M:
  If $f = \{\langle w1, \{j\}\rangle, \langle w2, \{m\}\rangle, \langle w3, \{j, m\}\rangle\}$, then $M = \{w1, w2\}$
  b. Prejacent of *dou*: $\Diamond f(j) \vee \Diamond f(m)$
  c. Applying *dou* yields a ∀-FC implicature: $\Diamond f(j) \wedge \Diamond f(m)$ (True in M)

  (33) *[John or Mary] **dou** must teach Intro Chinese.
  a. SI pre-restricts the modal base M:
  If $f = \{\langle w1, \{j\}\rangle, \langle w2, \{m\}\rangle, \langle w3, \{j, m\}\rangle\}$, then $M = \{w1, w2\}$
  b. Prejacent of *dou*: $\Box f(j) \vee \Box f(m)$
  c. Applying *dou* yields a ∀-FC implicature: $\Box f(j) \wedge \Box f(m)$ (False in M)

- **Remaining puzzle**: Why is that licensing the ∀-FCI use of *who* doesn't require a weak modal?

  A possibility: bare *wh*-words do not generate SIs.

  But this assumption makes it hard to capture the epistemic indefinite use of Mandarin *wh*-words. (See Chierchia & Liao 2015.)

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[6] The sub-alternatives of a pre-verbal item cannot be used by a covert *dou* (or any other covert pre-exhaustification exhaustifier), due to the economy condition for language-particular operations: "don't do covertly what you can do overtly" (Chierchia 1998). Since *dou* is a language-particular particle, overt *dou* and covert O_{DOU} have complementary distributions.

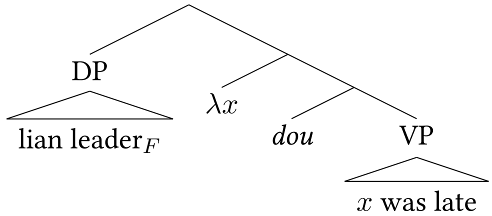
(1) a. Ni [renhe-ren] *(**dou**) keyi jian.
You any-person DOU can meet.
$^{\text{OK}}$*dou*/*O_{DOU} [you can meet anyone]

b. Ni (***dou**) keyi jian [renhe-ren].
You DOU can meet any-person
**dou*/$^{\text{OK}}O_{\text{DOU}}$ [you can meet anyone]

[7] Alternative approaches in the realm of exhaustifications include Dayal (2009) and Chierchia (2013). Dayal assumes a Fluctuation Constraint: in an *any*-sentence, the intersection of the restriction and the scope that verifies the sentence should not be constant across the accessible worlds. Chierchia assumes a Modal Containment Constraint: the FC and scalar implicatures have different modal bases; in particular, the one for FC is a proper subset of the one for SI.

6.1. The [*lian*...*dou*...] construction

- A [*lian*...*dou*...] sentence evokes an *even*-like reading:



(34) **Lian** [LINGDAO]$_F$ **dou** chidao -le.
LIAN leader DOU late -ASP
'Even the leader was late.'

- English *even* triggers an existential scalar presupposition: the propositional argument is less likely than some contextually relevant alternative. (Bennett 1982, Kay 1990; cf. Karttunen & Peters 1979)[8]

(35) $[\![\textit{even}]\!](p) = \exists q \in C[q >_{\text{likely}} p].p$
($[\![\textit{even}]\!](p)$ is defined only if p is more likely than some contextually relevant alternative; when defined, $[\![\textit{even}]\!](p) = p$)

- **Getting the *even*-like reading of [*lian*...*dou*...]**

When *dou* agrees with a *lian*-NP (or a non-scalar focused item), the measurement for ordering alternatives gets shifted from logical strength to likelihood. Sub-alternatives are the ones more likely than the prejacent. The pre-exhaustification effect is realized by the scalar exhaustifier JUST.

(36) a. $\textit{Sub}(p) = \{q : q \in \textit{Alt}(p) \wedge q >_{\text{likely}} p\}$
(The set of p that are more likely than p)
b. $\text{JUST}(q) = \lambda w[q(w) = 1 \wedge \forall r \in \textit{Alt}(q)[r(w) = 1 \rightarrow p \geq_{\text{likely}} r]]$
(q is true, and q is the most likely proposition among its true alternatives.)

We get a *dou* semantically equivalent to *even* (see computation in (38)): the additive presupposition of *dou* = the scalar presupposition of *even*; the assertion is vacuous.

(37) $[\![\textit{dou}]\!](p) = \lambda w[\exists q \in \textit{Sub}(p).\ p(w) = 1 \wedge \forall q \in \textit{Sub}(p)[\text{JUST}(q)(w) = 0]]$
$= \exists q \in \textit{Alt}(p)[q >_{\text{likely}} p].p \qquad = [\![\textit{even}]\!](p)$

(38) $[\![\textit{dou}]\!](p)$
$= \exists q \in \textit{Sub}(p).p \wedge \forall q \in \textit{Sub}(p)[\neg\text{JUST}(p)]$
$= \exists q \in \textit{Sub}(p).\lambda w[p(w) = 1 \wedge \forall q \in \textit{Sub}(p)\exists r \in \textit{Alt}(q)[r(w) = 1 \wedge q >_{\text{likely}} r]]$
$= \exists q \in \textit{Alt}(p)[q >_{\text{likely}} p].$
$\lambda w[p(w) = 1 \wedge \forall q \in \textit{Alt}(p)[q >_{\text{likely}} p \rightarrow \exists r \in \textit{Alt}(q)[r(w) = 1 \wedge q >_{\text{likely}} r]]]$
$= \exists q \in \textit{Alt}(p)[q >_{\text{likely}} p].p$

[Whenever p is true, then any alternative of p that is more likely than p is less likely than some true alternative r, where $r = p$.]

[8] Karttunen & Peters (1979) assumes a universal scalar presupposition: the propositional argument of *even* is less likely than all of its alternatives that are not identical to it. This presupposition is too strong. An *even*-sentence can also describe a non-extreme case. Examples in (2) are from Kay (1990:90).

(1) $[\![\textit{even}]\!](p) = \forall q \in C[p \neq q \rightarrow q >_{\text{likely}} p].p$

(2) a. Not only did Mary win her first round match, she even made it to the semi-finals.
b. The administration was so bewildered that they even had lieutenant colonels. making policy decisions

6.2. Minimizer-licensing

- **Fact 1:** Minimizers can be licensed in [*lian* MIN *dou* ...]. A post-*dou* negation is usually mandatory:

(39) Yuehan (lian) [YI-ge ren]$_F$ *(**dou**) *(bu) renshi.
John LIAN one-CL person DOU NEG know
'John doesn't know anyone.'

Analysis: Interpreting (39) involves reconstructing the minimizer, so as to satisfy the presupposition of *dou*. Without negation or if the minimizer scopes above negation, the prejacent clause of *dou* is logically the weakest among its alternatives (*a la* Crinč 2011 on English *even*).

(40) For any n > 1:
a. $\exists 1x \neg[\text{know}'(j,x)] \Leftarrow \exists nx \neg[\text{know}'(j,x)]$ MIN > NEG
b. $\neg\exists 1x[\text{know}'(j,x)] \Rightarrow \neg\exists nx[\text{know}'(j,x)]$ NEG > MIN

A minimizer cannot be licensed if it cannot be reconstructed to a position below negation.

(41) * (Lian) [YI-ge ren]$_F$ **dou** bu renshi Yuehan.
LIAN one-CL person DOU NEG know John.
Intended 'no one knows John.'

- **Fact 2**: The post-*dou* negation is optional in (42).

(42) Yuehan (lian) [YI-fen qian]$_F$ *(**dou**) (bu) xiang yao.
John LIAN one-cent money DOU NEG want request
With negation: 'John doesn't even want one cent.'
Without negation: 'John wants it even if it is just one cent.'

Analysis: The desire predicate *xiang* 'want' is non-monotonic (Heim 1992, a.o.). If the minimizer takes scope below *xiang*, the alternatives are semantically independent.

(43) [**dou** [John$_i$ want$_{\text{NM}}$ [**one-cent** λx [e$_i$ has x]]]]

We can order the alternatives based on likelihood. Sub-alternatives are the ones more likely than the prejacent: it is more likely that John wants more than one cent.

6.3. Associating with a scalar item

- Associating *dou* with a scalar item implies that the prejacent ranks relatively high in the contextually relevant scale. The associated item can appear on the right side of *dou* but must be stressed.

(44) a. It is **dou** FIVE o'clock! $\rightsquigarrow$ It's too late.
b. John **dou** has eaten THREE burgers! $\rightsquigarrow$ John has eaten too much.

When *dou* agrees with a focused scalar item, alternatives are ordered w.r.t. a contextually determined measurement μ.Sub-alternatives are the ones ranking lower than the prejacent w.r.t. μ. The pre-exhaustification effect is realized by the scalar exhaustifier JUST.

(45) $[\![dou]\!](p) = \lambda w[\exists q \in \textit{Sub}(p).\ p(w) = 1 \wedge \forall q \in \textit{Sub}(p)[\text{JUST}(q)(w) = 0]]$
a. $\textit{Sub}(p) = \{q : q \in \textit{Alt}(p) \wedge p >_\mu q\}$
(The set of alternatives of p that rank lower than p w.r.t. μ)

b. $\text{JUST}(q) = \lambda w[q(w) = 1 \wedge \forall r \in \textit{Alt}(p)[r(w) = 1 \rightarrow r \geq_\mu q]]$
(r is true; r ranks the highest w.r.t. μ among its true alternatives.)

A toy example:

(46) **Dou** [WU$_F$-dian] -le.
DOU five-o'clock -ASP
'It is **dou** FIVE$_F$ o'clock.'
a. *Sub* (**it's 5 o'clock**) = {*it's 4 o'clock, it's 3 o'clock*, ...}
b. ⟦**dou** [**it's 5 o'clock**]⟧ = 'it's 5, not just 4, not just 3, ...'

7. Sorting the parameters: Logical strength vs. likelihood

- Two basic ways to define sub-alternatives:

Def A: weaker than the prejacent; [9] (based on logical strength)

Def B: more likely than the prejacent. (based on likelihood)

Def A is strictly stronger than Def B : due to rule (47), if a proposition is logically weaker than the prejacent, it is also more likely than the prejacent; but not the other direction.

(47) Entailment and scalarity (Crinč 2011:15)
If $p \subset q$, then $p <_{\text{likely}} q$.

- Assuming that the logical strength-based semantics is basic, and that the likelihood-based semantics is derived[10] and is only licensed in [*lian...dou...*], I predict the following distributional pattern of *dou*:

If the prejacent is ...	Can *dou* be licensed in...	
	(i) basic declaratives?	(ii) [*lian...dou...*] constructions?
a. the logically strongest alt	Yes	Yes
b. the logically weakest alt	No	No
c. neither	**No**	Yes

The prediction for (c-i) is empirically supported (capitalizing marks stress):

(48) a. They **dou** bought houses. (#collective, √distributive)
b. (Lian) THEY **dou** bought houses. (√collective,√distributive)

(49) a. * John **dou** arrived.
b. (Lian) JOHN **dou** arrived.

[9]For now, I have to neglect the complications of innocent excludability. If an alternative is stronger but not I-excludable, it is still less likely than the prejacent. One option is to pursue the following path, where the *even*-like and FCI-licenser uses of *dou* are derived from the distributor-quantifier use by weakening the def of sub-alternatives.

The derivation path of sub-alternatives: A → B, A → C where
A. $\textit{Sub}(p) = (\textit{Alt}(p) - \textit{Excl}(p)) - \{p\}$
B. $\textit{Sub}(p) = \{q : q \in \textit{Alt}(p) \wedge q >_{\text{likely}} p\}$
C. $\textit{Sub}(p) = (\textit{Alt}(p) - \textit{IExcl}(p)) - \{p\}$

[10]This idea is supported by diachronic evidence. The quantifier-distributor use of *dou* emerges as early as the Eastern Han Dynasty (25-220) (Gu 2015), while the *even*-like use in the [*lian...dou*] construction emerges around the Ming Dynasty (1368-1644). I thank Feng Gu (p.c.) for data in Ancient Chinese.

The prediction for (c-i) favors my proposal over Liu's (2016). Liu treats the likelihood-based semantics as the default semantics of *dou*. But, if this were the case, *dou* should be licensed whenever its likelihood-based semantics is satisfied, and hence should have the same distribution in (i) and (ii), contra the fact.

For example, for (48a), if 'they bought houses together' $>_{\text{likely}}$ 'the others bought houses together', the likelihood-based semantics of *dou* would be licensed even if the prejacent takes a collective reading.

8. Conclusions

- *Dou* is a special exhaustifier which (i) operates on pre-exhaustified sub-alternatives and (ii) presupposes the existence of a sub-alternative.

– Default case (distributor and FCI-licenser):

(50) a. $[\![dou]\!](p) = \lambda w[\exists q \in \textit{Sub}(p).\ p(w) = 1 \land \forall q \in \textit{Sub}(p)[O(q)(w) = 0]]$
i. Presupposition: the prejacent has some sub-alternative(s).
ii. Assertion: the prejacent is true, the exhaustification of each sub-alternative is false.
b. $\textit{Sub}(p) = (\textit{Alt}(p) - \textit{IExcl}(p)) - \{p\}$
(the set of alternatives excluding the I-excludable alternatives and the prejacent itself)

– Scalar marker

(51) a. $[\![dou]\!](p) = \lambda w[\exists q \in \textit{Sub}(p).\ p(w) = 1 \land \forall q \in \textit{Sub}(p)[\textsc{just}(q)(w) = 0]]$
b. $\textit{Sub}(p) = \{q : q \in \textit{Alt}(p) \land q >_{\text{likely}} p\}$ if in a [*lian* ... *dou*] construction
c. $\textit{Sub}(p) = \{q : q \in \textit{Alt}(p) \land q <_{\mu} p\}$ if associated with a scalar item

- The assertion of *dou* is responsible for the derivation of ∀-FC inferences.
- The presupposition of *dou* is responsible for:
  (i) the distributivity and plurality requirements of distributor/quantifier-*dou*,
  (ii) the *even*-like semantics of a [*lian*...*dou*...] construction,
  (iii) the licensing conditions of minimizers in [*lian* MIN *dou*...] constructions,
  (iv) the scalar inferences in cases where *dou* is associated with a scalar item.

Appendix: Alternative proposals in the realm of exhaustifications

Liao (2012: ch. 4)

- The particle *dou* is a focus indicator and has no meaning *per se*. It signals the use of an E-operator (≈ *even*) (Krifka 1995, Chierchia 2013) and assigns an [+add] feature to the ∼-operator (Rooth 1985).

(52) [E [$\sim_{\text{[+add], C}}$ [$_{\text{douP}}$ they$_i$ [dou t_i arrived]]]]
a. $[\![\text{E}]\!](p) = \forall q \in \textit{Alt}(p)[p \neq q \rightarrow p <_{\text{likely}} q].p$
b. $[\![\sim_{\text{[+add], C}}]\!](p) = \lambda w[\exists q \in C[q \neq p \land q(w) = 1] \land \forall q \in C[q \neq p \rightarrow (\Diamond q)(w) = 1]].p$

The *even*-like meaning is due to the presupposition of the E-operator. This presupposition is trivially satisfied when *dou* applies to a distributive statement.

When *dou* is associated with a *wh*-item, the presupposition of the $\sim_{\text{[+add], C}}$-operator forces the prejacent to be recursively exhaustified, yielding a ∀-FC inference.

(53) [E [$\sim_{\text{[+add], C}}$ [O$_R$ [$_{\text{douP}}$ who$_i$ [dou t_i arrived]]]]]

- Problems:

  1. The *even*-inference of a *dou*-clause is always local. The locality effect is not predicted: if a downward-entailing operator is inserted between E and *dou*, we wouldn't get the *even* reading.

     (54) If lian JOHN$_F$ dou came, Mary would be happy.
     ⇝ John is less likely to come compared with others.
     a. If E [**lian** JOHN$_F$ **dou** came], Mary will be happy √
     b. E [if **lian** JOHN$_F$ **dou** came, Mary will be happy] ×

  2. The additive presupposition is too strong.

     (55) (**Lian**) JOHN$_F$ **dou** passed the exam, how come that the others all didn't!

  3. In (53), due to the Relativized Minimality, the E-operator has nothing to be associated with. Liao assumes that E is then associated with IP, whose focus value is purely determined by context.

  4. The violation to the additive presupposition of the $\sim$-operator could also be salvaged by any DE operators, and then the ∀-FC inference wouldn't be forced, contra the fact.

     (56) He didn't what **dou** buy.
     Predicted LF: [E [$\sim_{\text{[+add], C}}$ [not [what$_i$ [dou [he bought t_i]]]]]
     a. Desired reading: He didn't buy everything, (but he still bought something.)
     b. Predicted reading: He didn't buy anything.

Liu (2016)

- Liu (2016) adopts Karttunen & Peter's (1979) semantics of *even* and defines *dou* as equal to *even*:

  (57) $[\![\textit{dou}]\!](p) = \forall q \in \textit{Alt}(p)[p \neq q \rightarrow p <_{\text{likely}} q].p$
  (*dou* is truth conditionally vacuous but presupposes that its prejacent is the most unlikely proposition among its alternatives.)

  When *dou* applies to a distributive statement, the prejacent entails all the alternatives, and thus the presupposition gets trivially satisfied.

  Liu (2016) also make improvements on the treatment of distributivity/collectivity in the derivation of alternatives.

- Problems:

  1. Treating *dou* as *even* is incompatible with the fact that *dou* has more limited distribution in basic declaratives than in [*lian* ...*dou*...] constructions. (See section 7)
  2. The universal scalar presupposition is too strong. *Dou* can be used in non-extreme cases.

     (58) a. [The kids] **dou** arrived, the teachers also arrived.
     b. **only** [the kids] arrived, # the teachers also arrived.

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