Getting quantifying-into questions uniformly: functionality, exhaustivity, and QVE

Goals and Facts Questions like (1a-b) have readings involving quantifying-into questions, intuitively read as: "for each/one of the students x, which book did x read?".

(1) a. Which book did every/each student read? (pair-list reading of $Q_\forall$)
b. Which book did one of the students read? (choice readings of $Q_\exists$)

We provide an account that derives quantifying-into question uniformly and predicts the following three facts. Fact 1: the pair-list reading of $Q_\forall$ is subject to *domain exhaustivity* and *point-wise uniqueness*; (1a) presupposes that every student read one book and that no one read more than one book. Moreover, domain exhaustivity is more robust a $Q_\forall$ than in a multi-*wh*-question. For example, (2b) presupposes that every candidate will get one of the three jobs and thus suffers presupposition failure, but (2a) does not.

(2) (Context: 200 candidates are competing for 3 job openings.)
a. √ Guess which candidate will get which job. b. # Guess which job every candidate will get.

Fact 2: when modified by a quantificational adverbial (e.g., *for the most part*), an embedding of (1a) is subject to the *quantificational variability* (QV) effect, as in (3) (Berman 1991, a.o.).

(3) For the most part, Jenny knows which paper every/each student read.
⇝ Most x [x is a student] [Jenny knows which paper x read]

Fact 3: coordinating a ∀-quantifier with decreasing quantifier blocks the pair-list reading relative to this ∀-quantifier, as in (4a); but coordinating it with a ∃-quantifier does not, as in (4b).

(4) a. Which toy did [every boy and {no, less/more than two} girl(s)] buy?(×pair-list for *every boy*)
b. Which toy did [every boy and one of the girls] buy? (√pair-list for *every boy*)

Reviewing Dayal and Fox Among a rich literature, Dayal (1996, 2017) and Fox (2012) predict the domain exhaustivity and point-wise uniqueness effects of (1a). Dayal proposes a FUNCTION-BASED APPROACH and defines (1a) as a set of conjunctive propositions (5a), each of which specifies a Skolen function from the domain of the ∀-subject to the domain of the *wh*-object, yielding domain exhaustivity. Then, applying an ANS_{Dayal}-operator (5b) returns the unique strongest true member in Q, yielding point-wise uniqueness.

(5) a. $Q_\forall = \{\bigcap\{{}^\wedge\mathsf{read}(x, \mathsf{f}(x)) \mid x \in \mathsf{stdt}_@\} \mid \mathsf{f} \in [\mathsf{stdt}_@ \rightarrow \mathsf{book}_@]\}$
b. $\text{ANS}_{Dayal}(Q)(w) = \iota p[w \in p \in Q \wedge \forall q[w \in q \in Q \rightarrow p \subseteq q]]$

Fox proposes a FAMILY-OF-QUESTION APPROACH and defines (1a) as set of proposition sets (6d), derived via the LF (6b). This LF is read as "the minimal K s.t. 'which book did x read?' is in K for every student x", which is simply the set consisting of all the sub-questions. Next, a point-wise ANS_{PW}-operator imposes ANS_{Dayal} to each sub-question and returns the conjunction of all the derived answers, yielding domain exhaustivity and point-wise uniqueness.

(6) a. $Q_\forall = \{\{{}^\wedge\mathsf{read}(x, y) \mid y \in \mathsf{book}_@\} \mid x \in \mathsf{student}_@\}$
b. $[_{Q_\forall}$ MIN λK $[_{\text{CP2}}$ $[_{\text{DP}}$ every student$]$ λx K $[_{\text{CP1}}$ which book did x read$]]]$
c. $\text{MIN} = \lambda\alpha.\iota K[K \in \alpha \wedge \forall K' \in \alpha[K' \subseteq K]]$ (Pafel 1999)

First, compare Dayal and Fox. Dayal keeps the semantic type of questions low, but she cannot account for the QV effect in (3): conjuncts of a conjunctive proposition cannot be retrieved out of this proposition (Lahiri 2002). Fox makes the type complex, but he can capture the QV effect: MOST quantifies over a set of sub-questions. Second, neither account extends to $Q_\exists$. In Dayal's derivation, the domain of a subject-quantifier is retrieved as retrieving the unique *minimal witness set* of the quantifier (B&C 1983). Since only a ∀-quantifier has a unique minimal witness set, her derivation only works for ∀-questions. Likewise, Fox uses a MIN-operator to get the unique minimal K set that satisfies a quantified predication relation, which exists only if the predication is universally quantified. Dayal and Fox limit their derivations to ∀-questions on purpose; they want to predict that only ∀-questions admit pair-list readings. But, they cannot account for Fact 3 that decreasing quantifiers block pair-list while ∃-quantifiers do not.

Xiang (2016) Our general treatment of questions follows a categorial approach by Xiang (2016, 2018), which defines a *wh*-question as a topical property (P), i.e., a function from short answers to propositional answers. In the derivation, a *wh*-phrase denotes an ∃-quantifier, but is shifted into a polymorphic domain restrictor via a BeDom-operator (7b). A topical property can supply shot answers, derived by exercising an Ans^S-operator (7c) adapted from Ans_{Dayal}, which checks the existence of the strongest true answer.

(7) a. Who came?: (i) LF: $[_{\text{CP}}\ [_{\text{DP}}\ \text{BeDom(who)}]\ \lambda x\ [_{\text{IP}}\ x \text{ came}]]$; (ii) $P = \lambda x : \text{hmn}(x).{}^\wedge\text{came}(x)$

b. $\text{BeDom}(\mathcal{P}) = \lambda\vartheta_\tau.\iota P_\tau[[\text{Dom}(P) = \text{Dom}(\vartheta) \cap \text{Be}(\mathcal{P})] \wedge \forall\alpha \in \text{Dom}(P)[P(\alpha) = \vartheta(\alpha)]]$

c. $\text{Ans}^S(P)(w) = \iota\alpha[\alpha \in \text{Dom}(P) \wedge w \in P(\alpha) \wedge \forall\beta \in \text{Dom}(P)[w \in P(\beta) \rightarrow P(\alpha) \subseteq P(\beta)]]$

Proposal We compose (1a-b) uniformly via the LF (8). The question nucleus (viz., $\bigcap$[IP3]) is structured a la Fox, read as "the conjunction of a minimal K s.t. the proposition 'x read f(x)' is in K for every/one/no student x." *Wh*-movement leaves a functional trace, whose argument is bound by the subject-quantifier (*a la* Engdahl 1980, 1986; Chierchia 1993; Dayal 1996).

(8) $[_{\text{CP}}[_{\text{DP}}\ \text{BeDom(wh-book)}]\ \lambda f \bigcap\ [_{\text{IP3}}\ E_{\text{MIN}}\ \lambda K\ [_{\text{IP2}}\ [_{\text{DP}}\ \text{every/one/no stdt}]\ \lambda x\ [K\ [_{\text{IP1}}\ x \text{ read f}(x)]]]]]$

While taking insights from Fox and Dayal, this approach has three novel pieces. First, in $Q_\forall$, the quantificational predication denoted by IP2 is defined only if the function f is defined or every student, yielding indefeasible domain exhaustivity. Fact 1 is explained. Second, unlike Pafel-Fox's min-operator, the E_{MIN}-operator (≈ Winter's (2001) collectivity raising operator) defined in (9) doesn't presuppose uniqueness. In $Q_\forall$, IP3 denotes a full set, yielding pair-list; in $Q_\exists$, IP3 denotes a singleton set with an unfixed value, giving rise to a choice flavor. If the quantifier is decreasing, IP denotes an empty set and the topical property is undefined, and thus questions with a decreasing quantifier cannot have quantifying-into questions.

(9) $[\![E_{\text{MIN}}]\!] = \lambda\alpha.f_{\text{CH}}\{K : K \in \alpha \wedge \forall K' \in \alpha[K \not\subset K']\}$

	a minimal K set (IP3)	topical property (CP)
$Q_\forall$	$\{{}^\wedge\text{read}(x, \text{f}(x)) \mid x \in \text{stdt}_@\}$	$\lambda \text{f}\!: \text{Ran(f)} \subseteq \text{book}_@ \wedge \text{stdf}_@ \subseteq \text{Dom(f)}. \bigcap\{{}^\wedge\text{read}(x, \text{f}(x)) \mid x \in \text{stdt}_@\}$
$Q_\exists$	$\{{}^\wedge\text{read}(x, \text{f}(x))\}, x \in \text{stdt}_@$	$\lambda \text{f}\!: \text{Ran(f)} \subseteq \text{book}_@ \wedge \text{stdf}_@ \cap \text{Dom(f)} \neq \emptyset. {}^\wedge\text{read}(x, \text{f}(x)), x \in \text{stdt}_@$

In (4) with a quantifier coordination "∀ and X", E_{MIN} returns a minimal K set that satisfies both quantificational predications. If X is decreasing, the derived minimal K set and topical property are identical to those derived without X, which violates economy and is thus deviant. Fact 3 is explained. Third, unlike Dayal, this approach defines (1a) as a function from Skolem functions to propositions, out of which we can retrieve all the student-read-book pairs as retrieving the strongest true short answer. For example, if student $s_1 s_2 s_3$ read book $b_1 b_2 b_3$ in w respectively, $\text{Ans}^S(P)(w) = [s_1 \rightarrow b_1, s_2 \rightarrow b_2, s_3 \rightarrow b_3]$. The QV inference in (3) is as (10b). The domain of the matrix adverbial is a set of atomic functions. (See also Cremers 2018.) The scope involves Jenny knowing a sub-divisive inference. This inference is true iff in every world w' that is compatible with Jenny's belief, the strongest short answer of the embedded $Q_\forall$ in w' is one of the seven functions list in the partition in Figure 2. (NB: the scope cannot be written as $\text{know}_w(j, P(\text{f}'))$, because P is only defined for functions that are defined for every student.) Fact 2 is explained.

(10) a. $\text{At(f)} = \{\text{f}' : \text{f}' \subseteq \text{f and} \bigoplus \text{Dom}(\text{f}') \text{ is atomic}\}$

b. $\lambda w.\text{Most f}'[\text{f}' \in \text{At}(\text{Ans}^S(P)(w))][\text{know}_w(j, \lambda w'.\text{f}' \leq \text{Ans}^S(P)(w'))]$
(For most f′ that are atomic subparts of the strongest true short answer of Q (viz, $\text{f}' \in \{[s_1 \rightarrow b_1], [s_2 \rightarrow b_2], [s_3 \rightarrow b_3]\}$), J knows f′ is a subpart of the strongest true short answer of Q.)

	$s_1 \to b_2$ $s_2 \to b_2$ $s_3 \to b_3$	$s_1 \to b_3$ $s_2 \to b_2$ $s_3 \to b_3$
$s_1 \to b_1$ $s_2 \to b_1$ $s_3 \to b_3$	$s_1 \to b_1$ $s_2 \to b_2$ $s_3 \to b_3$	$s_1 \to b_1$ $s_2 \to b_3$ $s_3 \to b_3$
$s_1 \to b_1$ $s_2 \to b_2$ $s_3 \to b_1$	$s_1 \to b_1$ $s_2 \to b_2$ $s_3 \to b_2$	

(Each cell represents a set of worlds where the student-read-book pairs are as the function enclosed.)

Figure 1: Illustration of (10b)

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