The categorial approach

Core assumption

The meaning of questions is defined based on possible **short** answers.

(1) $[\![\text{which girl smiled}]\!]^{w_0} = \left\{ \begin{array}{ll} \langle \mathsf{a}, w_0\rangle, & \langle \mathsf{b}, w_1\rangle, \\ \langle \mathsf{c}, w_1\rangle, & \langle \mathsf{c}, w_2\rangle \end{array} \right\}$

(2) $[\![\text{which girl smiled}]\!]^{w_0} = \lambda x \lambda w : \mathsf{girl}_{w_0}(x).\mathsf{smiled}_w(x)$

Answerhood

(3) A: Which girl smiled?
B: (i) Anna. (ii) Anna smiled.

Deriving true short answers:

$$\boxed{\mathsf{Ans}^S_{w_0}(P) \;=\; \iota x.x \;\in\; \mathsf{Dom}(P) \wedge P(x)(w_0)}$$

i.e., THE entity that makes true the function P denoted by a question (see Xiang 2021 for a sophisticated version)

Deriving true full answers:

(4) $\mathsf{Ans}(w_0)(P) = P(\mathsf{Ans}^S(w_0)(P))$

✓ Full answers are derived from short answers.

Debate: Semantics vs. Syntax

Short answers are derived from full answers via ellipsis.

Merchant (2004)

(5) A: [Which book]$_1$ did Jill read t_1?
B: *Emma*$_1$ [~~Jill read t_1~~]

Jacobson (2016): Short answers are not semantically equivalent to full answers.

(6) Which math professor left the party at midnight?
a. Jill. $\rightsquigarrow$ Jill is a math professor
b. Jill did. $\not\rightsquigarrow$ Jill is a math professor
c. Jill left the party at midnight. $\not\rightsquigarrow$ Jill is a math professor

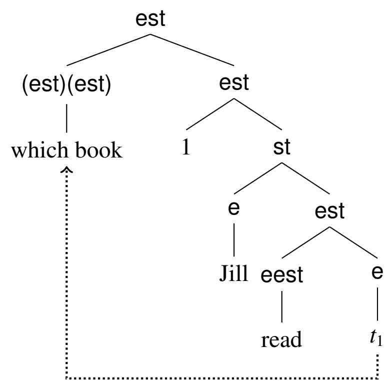
Weir (2014): clausal ellipsis must inherit a presuppositional restriction.

✓ The debate is still there.

Composition

Wh-expressions denote restrictions of functions.

(7) $[\![\text{which book}]\!]^{w_0} = \lambda P \lambda x \lambda w : \mathsf{book}_{w_0}(x).P(x)$ (est)(est)



Free relatives

Semantic similarities between *wh*-questions and free relatives (Chierchia & Caponigro 2013)

Mention-all

(8) What did Jill cook? — Pasta.
$\rightsquigarrow$ All food that Jill cooked is pasta.

(9) Peter ate what Jill cooked.
$\rightsquigarrow$ Peter ate all food that Jill cooked.

Mention-some

(10) Where can I buy coffee? — Starbucks.
$\rightsquigarrow$ Starbucks is just one coffee shop.

(11) Jill went to where she could buy coffee.
$\rightsquigarrow$ Jill went to a place where she could buy coffee.

✓ Unification: The meaning of a free relative equals to the true short answer to the corresponding *wh*-question (Xiang 2021; see also Jacobson 1995; Caponigro 2003).

Question: why are some *wh*-expressions not used to form free relatives? (Caponigro 2003)

(12) *Peter ate {what / which} food Jill cooked.

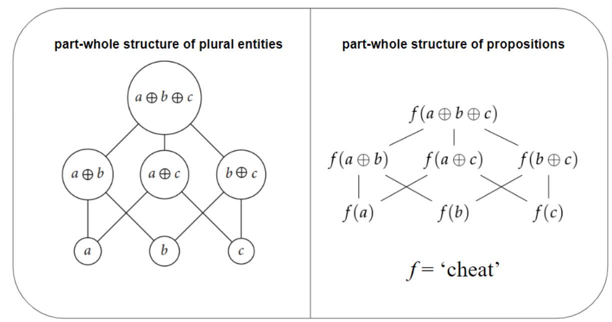
(13) *I did it why you did it.

Quantificational Variability

(14) Sarah knows, **for the most part**, who cheated.
$\rightsquigarrow$ For most people who cheated, Sarah knows they cheated.

(15) The school paper recorded, **in part**, what made the dean's list.
$\rightsquigarrow$ For some people who made the dean's list, the school paper recorded they made the dean's list.

- **H1:** Quantification over short answers (Berman 1991)
$\mathsf{most}\ x.\ x \leq_{\mathsf{atom}} \mathsf{Ans}^S_{w_0}[\![\text{who cheated}]\!]: \mathsf{know}(\mathsf{cheat}(x))(\mathsf{s})$
- **H2:** Quantification over full answers (Lahiri 2000)
$\mathsf{most}\ p.\ p \leq_{\mathsf{atom}} \mathsf{Ans}_{w_0}[\![\text{who cheated}]\!]: \mathsf{know}(p)(\mathsf{s})$



Williams' (2000) puzzle

(16) For the most part, Sarah knows who formed the committee.
$\rightsquigarrow$ For most committee members, Sarah knows they are **part of** the committee.

The full answer to the embedded *wh*-question does not have atomic parts. **H2** is challenged.

formed.cmt($a \oplus b \oplus b$)
formed.cmt(a) ✖
formed.cmt(b) ✖
formed.cmt(c) ✖

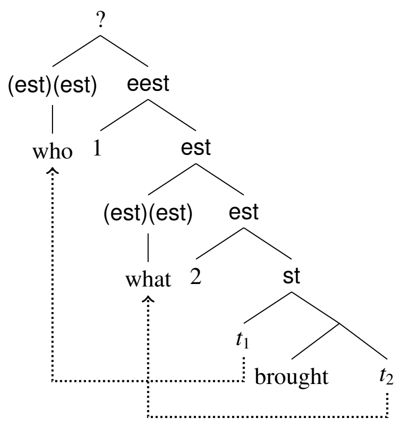
Under **H1**, the meaning of (16) can be formulated as:

(17) $\mathsf{most}\ x.\ x \leq_{\mathsf{atom}} \mathsf{Ans}^S_{w_0}[\![\text{who formed the committee}]\!]$: $\mathsf{know}(\underline{\mathsf{in.cmt}}(x))(\mathsf{s})$ Xiang (2021)

Question: How is (17) compositionally derived? Where does the underlined part come from? (see Cremers (2018) for a solution)

Multiple-*wh* questions

(18) Who brought what?



Xiang's (2021) solution

Karttunen (1977): *wh*-expressions are existential quantifiers

(19) $[\![\text{who}]\!]^{w_0} = \lambda P \lambda w \exists x.\mathsf{human}_{w_0}(x) \wedge P(x)(w)$ (est)st

Partee (1986): Shifting existential quantifiers to properties

(20) $\mathbf{Be}(\mathcal{P}) = \lambda x.\mathcal{P}(\lambda y \lambda w.y = x)$

A new type shifter **BeDom**:

> $\mathbf{BeDom}(\mathcal{P}) = \lambda f \iota g.g$ is a function such that:
>
> 1. $\mathsf{Dom}(g) = \mathsf{Dom}(f) \cap \mathbf{BE}(\mathcal{P})$ and
> 2. $\forall x \in \mathsf{Dom}(g).g(x) = f(x)$

i.e., for any function f, **BeDom** restricts the domain of f with **BeDom**($\mathcal{P}$).

(21) $\mathbf{BeDom}[\![\textit{what}]\!]^{w_0} = \lambda f_{ea}\, \underbrace{\lambda y : y \in \mathsf{thing}_{w_0}.f(y)}_{ea}$

(22) $\mathbf{BeDom}[\![\textit{who}]\!]^{w_0} = \lambda f_{ea}\, \underbrace{\lambda y : y \in \mathsf{human}_{w_0}.f(y)}_{ea}$

✓ A shifted *wh*-expression can combine with a function of any type (Note: a is a variable of type).

Comparison: Chung & Ladusaw (2003) propose a new compositional mode **Predicate Restriction**.

(23) $\mathbf{Restrict}\,(\lambda x \lambda y.f(x)(y), \lambda x.g(x)) = \lambda x \lambda y.f(x)(y) \wedge g(x)$

Wh-coordination

(24) Jenny knows who came and who brought what.

- ⟦who came⟧: est
- ⟦who brought what⟧: eest

However, two elements of different types cannot be coordinated.

(25) a. *Peter brought and came a cake.
b. *Susan and student came.

Xiang's (2021) solution

Questions take scope (see also Krifka 2001).

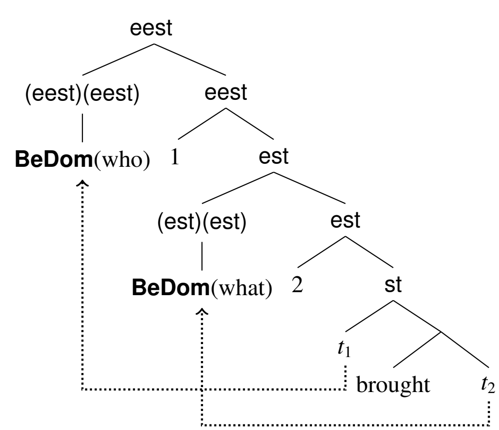
(26) $\underbrace{[\text{who came and who brought what}]}_{\lambda f.f(Q_1) \wedge f(Q_2)}\ \lambda Q$ Jenny knows Q

☺ Both $f(Q_1)$ and $f(Q_2)$ are of type t, so they are conjoinable.

However, ...

☹ f doesn't have a fixed type!
(see Xiang's response on pg 640, ft 34)

Note: No matter which technique is used to resolve the problem, it shouldn't be applicable to the examples in (25).



(27) The denotation of (18):
$\lambda x \lambda y \lambda w : x \in \mathsf{thing}_{w_0} \wedge y \in \mathsf{human}_{w_0}.\mathsf{brought}_w(x)(y)$

The type of (18) is eest.

✓ A single-*wh* question and a multiple-*wh* question don't have **different** types.

Other types of questions

(28) ⟦Did Mary meet Jane or Peter⟧
$= \lambda x \lambda w : x \in \{\mathsf{j}, \mathsf{p}\}.\mathsf{met}_w(x)(\mathsf{m})$

(29) ⟦Did Mary leave⟧
$= \lambda f : f \in \{\lambda p.p, \lambda p.\overline{p}\}.f(\lambda w.\mathsf{left}_w(\mathsf{m}))$

Other variants

Structured meaning approach

von Stechow (1991); Krifka (2001)

Questions denote ordered pairs $\langle D, f \rangle$

(30) $[\![\text{who left}]\!]^{w_0} = \langle \mathsf{human}_{w_0}, \lambda x \lambda w.\mathsf{left}_w(x) \rangle$

(31) $[\![\ \text{John}_{\mathsf{F}}\ \text{left}]\!] = \langle \mathsf{j}, \lambda x \lambda w.\mathsf{left}_w(x) \rangle$

Question-answer congruence: A question-answer pair is congruent only if the focus component of the answer is in D and the background component of the answer is equal to f.

(32) A: Who left?
B: (i) John_{F} left.
(ii) #John $[\text{left}]_{\mathsf{F}}$.

Variable-free semantics

Jacobson (1999); Xiang (2019)

Variable-free Semantics can 'pass up' the information about an unfilled syntactic argument.

> Geach Rule: $\mathbf{g}(f) = \lambda g \lambda x.f(g(x))$

i.e., $\mathbf{g}$ shifts a function of type ab to a function of type $(ca)(cb)$.

1. ⟦and⟧: ttt $\xrightarrow{\mathbf{g}}$ (et)(ett) $\xrightarrow{\mathbf{g}}$ (eet)(eett)
2. $\mathbf{gg}$(⟦and⟧) ∘ ⟦who brought what⟧: eett
3. $\lambda x \lambda y.\mathbf{g}(\mathbf{gg}([\![\text{and}]\!]) \circ [\![\text{who brought what}]\!])(x)(y)$: ee(et)(et)
4. ⟦who left⟧: et $\xrightarrow{\mathbf{lift}}$ ((et)(et))(et) $\xrightarrow{\mathbf{g}}$ (e(et)(et))(eet) $\xrightarrow{\mathbf{g}}$ $\underline{\text{(ee(et)(et))}}$(eeet)

A potential problem: It is predicted that a *wh*-expression can be bound as a pronoun.

(33) Who knows who is a genius?
$\not\leadsto$ Who knows he is a genius?