PLING228 Semantics Research Seminar

Lecture 1: Introduction to Question Semantics

Yasutada Sudo January 15, 2016

1 Hamblin (1958) on Questions

- Truth-conditional semantics is primarily about declarative sentences/statements. How do we deal with other speech acts and sentence types, e.g. questions?
- Hamblin's Three Postulates (Hamblin 1958)
  1. *An answer to a question is a statement.*
  2. *Knowing what counts as an answer is equivalent to knowing the question.*
  3. *The possible answers to a question are an exhaustive set of mutually exclusive possibilities.*

1.1 Postulate 1: *An answer to a question is a statement.*

- An answer to a question is always a statement. When it seems it's not (a 'fragment answer'), it's an elliptical form.

(1) Who was in the room?
—John (was in the room).

- *Yes* and *no* are also statements:

> "yes" and "no" customarily represent statements: we might say that they are statements in code. (Hamblin 1958:162)

For example:

(2) Is it raining?
a. —Yes [= it is raining]
b. —No [= it is not raining]

Alternatively, *yes* and *no* mean nothing themselves, but signal that some answer is following them. What follows *yes* is a positive sentence, what follows *no* is a negative sentence. When nothing follows them, it's an elliptical form.

(3) Is it raining?
a. —Yes, (it is raining).
b. —No, (it is not raining).

- **Food for thought**: How would you analyse answers to negative questions?

(4) Is it not raining?
a. —Yes.
b. —No.

Some languages have a third particle (*doch* in German and Dutch, *si* in French).

1.2 Postulate 2: *Knowing what counts as an answer is equivalent to knowing the question.*

- NB: To know the meaning of a question, you don't need to know the *correct* answer. All you need to know is what is a *possible* answer.
- This postulate allows us to reduce the semantics of questions to the semantics of statements: The meaning of a question = the set of possible answers to it.
- Given Postulate 1, each possible answer is a statement, which we assume denotes a proposition.
- We assume possible world semantics where propositions are functions from possible worlds to truth-values (functions of type $\langle s, t \rangle$).

(5) $[\![\text{Is it raining?}]\!] = \{\, [\lambda w'_s.\ \text{it is raining in } w'],\ [\lambda w'_s.\ \text{it is not raining in } w'] \,\}$

- We do not distinguish sets and their characteristic functions. So we can regard each proposition as the set of worlds in which it is true.

(6) $[\![\text{Is it raining?}]\!] = \{\, \{\, w'_s \mid \text{it is raining in } w' \,\},\ \{\, w'_s \mid \text{it is not raining in } w' \,\} \,\}$

1.3 Postulate 3: *The possible answers to a question are an exhaustive set of mutually exclusive possibilities.*

1.3.1 Exhaustivity and Presupposition

- For Hamblin (1958), a question is *logically proper* if its denotation covers the entire set of possible worlds, $\mathcal{W}$:

(7) $\bigcup [\![\text{Is it raining?}]\!] = \mathcal{W}$

- But not all yes/no questions cover the entire set of possible worlds. Such questions have *presuppositions*.

> The necessity for the set of possible answers to be exhaustive is illustrated by the classical "Have you stopped beating your wife?", which is a logically improper question just because the indicated answers "yes" and "no" do not, on the usual reckoning, cover all the logical possibilities. The question "In which continent is Luxembourg?" is like this too, because it presupposes that Luxembourg is in a continent [...] (Hamblin 1958:163)

(8) $[\![\text{Have you stopped beating your wife?}]\!]$
$= \left\{ \begin{array}{l} [\lambda w'_s.\ \text{you have stopped beating your wife in } w'], \\ [\lambda w'_s.\ \text{you have not stopped beating your wife in } w'] \end{array} \right\}$

Worlds where you never beat your wife or worlds where you don't have a wife are not in the union of (8).

- Hamblin has a modern view on presuppositions:

> When the indicated answers to a question are not exhaustive one can of course alternatively say that the question is a perfectly proper one *relative to* a certain supposition, namely the supposition expressed by the disjunction of the indicated answers. (Hamblin 1958:164)

Stating this in the Stalnakerian pragmatics: A question is proper (or felicitous) if the union of its answers covers all the possible worlds in the set of worlds that represents the common ground (the Context Set) at the time of utterance.

1.3.2 Mutual Exclusiveness and Answerhood

- Another feature of Hamblin's (1958) semantics is that the answers need to be mutually exclusive. This is to capture the notion of *complete answers*:

> Suppose on being asked "In which continent is Luxembourg?" I were to reply "Either Europe, or Asia, or Africa". It might easily be objected that I had not given a proper answer in the sense that I had not given a *complete* answer. This objection might now be put another way: The answer "Either Europe, or Asia, or Africa" cannot be a proper answer, because it does not exclude and is not excluded by other proper answers, e.g. the answer "Europe". *Complete* answers are mutually exclusive, and this is simply one of the things we mean by "completeness". (Hamblin 1958:164)

- Example:

(9) A: In which continent is Luxembourg?
B: Either Europe, or Asia, or Africa.

Under Hamblin's analysis, (9A) denotes:

$$(10)\quad \left\{ \begin{array}{l} \{ w'_s \mid \text{Lexembourg is in Europe in } w' \}, \\ \{ w'_s \mid \text{Lexembourg is in Asia in } w' \}, \\ \{ w'_s \mid \text{Lexembourg is in Africa in } w' \}, \\ \{ w'_s \mid \text{Lexembourg is in North America in } w' \}, \\ \{ w'_s \mid \text{Lexembourg is in South America in } w' \}, \\ \{ w'_s \mid \text{Lexembourg is in Australia in } w' \}, \\ \{ w'_s \mid \text{Lexembourg is in Antarctica in } w' \} \end{array} \right\}$$

(9B) denotes the union of the first three sets of possible worlds:

$$\{ w'_s \mid \text{Lexembourg is in Europe, or Asia, or Africa in } w' \}$$

This is a *partial answer* to the question (9A). It only settles the question partially.

- Notice that for Hamblin, *wh*-questions also denote sets of mutually exclusive answers.

$$(11)\quad [\![\text{Who left?}]\!] = \left\{ \begin{array}{l} \{ w'_s \mid \text{John and nobody else left in } w' \}, \\ \{ w'_s \mid \text{Bill and nobody else left in } w' \}, \\ \{ w'_s \mid \text{Mary and nobody else left in } w' \}, \\ \ldots \\ \{ w'_s \mid \text{John and Bill and nobody else left in } w' \}, \\ \{ w'_s \mid \text{John and Mary and nobody else left in } w' \}, \\ \{ w'_s \mid \text{Bill and Mary and nobody else left in } w' \}, \\ \ldots \\ \{ w'_s \mid \text{John, Bill and Mary and nobody else left in } w' \}, \\ \ldots \end{array} \right\}$$

So *John left* is not a complete answer to (11). But one often means 'Only John left' by *John left*, which would be a complete answer, picking out the first set in (11).

- So in Hamblin Semantics, a question induces a partition of the space of (live) possibilities. Each cell of the partition is a complete answer.

> A question is equivalent to a decomposition (or section, or division) of the possible universes. The set of possible universes is split up into a number of subsets, each subset representing an answer to the question, i.e. consisting of exactly those universes consistent with the answer.
>
> A yes-no question divides the possible universes in two. So, of course, does a statement. But a statement also says which subset contains the actual universe: it polarises the division. A yes-no question merely draws the dividing line, it does not polarise. (Hamblin 1958:166)

1.4 Logical Calculous of Questions

- Containment (alt.: refinement): A question denotation Q_1 contains another question denotation if every (complete) answer to Q_1 leads to a (complete) answer to Q_2.

(12) Q_1 *contains* Q_2 ($Q_1 \sqsubseteq Q_2$) if for each $p_1 \in Q_1$, there is $p_2 \in Q_2$ such that $p_1 \subseteq p_2$.

(13) "In which continent is Ecuador?" is contained in "What is the latitude and longitude of Ecuador's highest mountain peak?" (taking the locations of the continents as axiomatic)

- Equivalence:

(14) Q_1 and Q_2 are *equivalent* ($Q_1 \equiv Q_2$) if $Q_1 \sqsubseteq Q_2$ and $Q_2 \sqsubseteq Q_1$.

- Join: The *join* of two questions is the (minimal) question that contains each of them.

(15) The join of Q_1 and Q_2 ($Q_1 \sqcup Q_2$) is the minimal Q such that $Q_1 \sqsubseteq Q$ and $Q_2 \sqsubseteq Q$.[1]

- Dually, we can define the *meet* of two questions:

(16) The meet of Q_1 and Q_2 ($Q_1 \sqcap Q_2$) is the maximal Q such that $Q \sqsubseteq Q_1$ and $Q \sqsubseteq Q_2$. I.e. $Q_1 \sqcap Q_2 := \{\, W \mid \exists W_1 \in Q_1 \exists W_2 \in Q_2 [W = W_1 \cap W_2 \wedge W \neq \varnothing] \,\}$

2 Compositional Semantics 1: Hamblin (1973)

2.1 A Quick Review of Intensional Semantics

- We translate Hamblin's (1973) system (which builds on a pre-PTQ Montague Grammar) in a more modern framework. Let's first review intensional semantics.
- A model $\mathcal{M} = \langle \mathcal{D}, \mathcal{W}, \mathcal{V} \rangle$ is a usual first-order model. The model parameter $\mathcal{M}$ is henceforth omitted.
- Types and Domains

(17)
a. e and t are types.
b. If σ andτ are types, then $\langle \sigma, \tau \rangle$ is a type.
c. If τ is a type, then $\langle s, \tau \rangle$ is a type.
d. Nothing else is a type.

(18)
a. D_e = the set $\mathcal{D}$ of individuals of the model.
b. $D_t = \{\, 0, 1 \,\}$.
c. If $\sigma \neq s$, $D_{\langle \sigma, \tau \rangle} = D_\tau^{D_\sigma}$ (the set of functions from D_σ to D_τ).

[1] Define the equivalence relations $\sim_1$ and $\sim_2$ as follows: $w \sim_1 w'$ iff $\exists W_1 \in Q_1 [w \in W_1 \wedge w' \in W_1]$, and $w \sim_2 w'$ iff $\exists W_2 \in Q_2 [w \in W_2 \wedge w' \in W_2]$. Take the transitive closure of the union of these equivalence relations, $\sim = (\sim_1 \cup \sim_2)^+$. $Q_1 \sqcup Q_2$ is the partition induced by $\sim$, i.e. $\{\, \{\, w' \mid w \sim w' \,\} \mid w \in \mathcal{W} \,\}$.

d. $D_{\langle s,\tau\rangle} = D_\tau^{\mathcal{W}}$ (the set of functions from $\mathcal{W}$ to D_τ).

- Denotations are intensions:

(19) a. $[\![\text{John}]\!]^g = [\lambda w_s.\ j]$
b. $[\![\text{walks}]\!]^g = [\lambda w_s.\lambda x_e.\ x \text{ walks in } w]$
c. $[\![\text{saw}]\!]^g = [\lambda w_s.\ \lambda x_e.\ \lambda y_e.\ y \text{ saw } x \text{ in } w]$

These combine via Extensional Functional Application:

(20) *Extensional Functional Application*
If $[\![\alpha]\!]^g \in D_{\langle s,\langle\sigma,\tau\rangle\rangle}$ and $[\![\beta]\!]^g \in D_{\langle s,\sigma\rangle}$, then $[\![\alpha\ \beta]\!]^g = [\![\beta\ \alpha]\!]^g = [\lambda w_s.\ [\![\alpha]\!]^g(w)([\![\beta]\!]^g(w))]$.

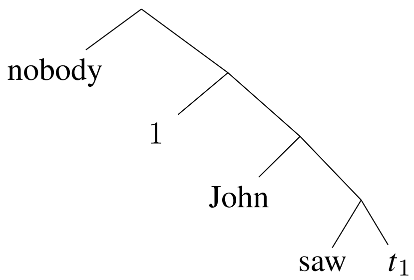
Intensional operators (modals) trigger Intensional Functional Application.

(21) $[\![\text{necessary}]\!]^g = [\lambda w_s.\ \lambda p_{\langle s,t\rangle}.\text{ for each } w' \text{ that is deontically accessible from } w,\ p(w') = 1]$

(22) *Intensional Functional Application*
If $[\![\alpha]\!]^g \in D_{\langle s,\langle\langle s,\sigma\rangle,\tau\rangle\rangle}$ and $[\![\beta]\!]^g \in D_{\langle s,\sigma\rangle}$, then $[\![\alpha\ \beta]\!]^g = [\![\beta\ \alpha]\!]^g = [\lambda w_s.\ [\![\alpha]\!]^g(w)([\![\beta]\!]^g)]$.

- Quantifiers covertly move (Quantifier Raising) and take scope.

(23)



The index node triggers Predicate Abstraction:

(24) *Predicate Abstraction*
$[\![i\ \text{XP}]\!]^g = [\lambda w_s.\lambda x_e.\ [\![\text{XP}]\!]^{g[i\mapsto x]}(w)]$

(25) $[\![\text{nobody}]\!]^g = [\lambda w_s.\ \lambda f_{\langle e,t\rangle}.\ \{\, x \mid f(x) = 1 \,\} = \varnothing]$

(26) $[\![1 \text{ John saw } t_1]\!]^g = [\lambda w_s.\lambda x_e.\ \text{John saw } x \text{ in } w]$

2.2 Hamblin Semantics

- Everything denotes a set of intensions.

(27) a. $[\![\text{John}]\!]_H = \{\, \lambda w_s.\ j \,\}$
b. $[\![\text{left}]\!]_H = \{\, \lambda w_s.\lambda x_e.\ x \text{ left in } w \,\}$

- Denotations combine via point-wise function application (which Hamblin denotes by “‘”).[2]

(28) *Hamblin Functional Application*
If $[\![\alpha]\!]_H \subseteq D_{\langle s,\langle\sigma,\tau\rangle\rangle}$ and $[\![\beta]\!]_H \subseteq D_{\langle s,\sigma\rangle}$,
then $[\![\alpha\ \beta]\!]_H = [\![\beta\ \alpha]\!]_H = \{\, \lambda w_s.\ a(w)(b(w)) \mid a \in [\![\alpha]\!]_H, b \in [\![\beta]\!]_H \,\}$.

(29) $[\![\text{John left}]\!]_H = \{\, \lambda w_s.\ a(w)(b(w)) \mid b \in \{\, \lambda w_s.\ j \,\}, a \in \{\, \lambda w_s.\lambda x_e.\ x \text{ left in } w \,\} \,\}$
$= \{\, \lambda w_s.\ j \text{ left in } w \,\}$

[2] If you want to take care of presupposition projection, it should read: If $[\![\alpha]\!]_H \subseteq D_{\langle s,\langle\sigma,\tau\rangle\rangle}$ and $[\![\beta]\!]_H \subseteq D_{\langle s,\sigma\rangle}$, then $[\![\alpha\ \beta]\!]_H = [\![\beta\ \alpha]\!]_H = \{\, \lambda w_s:\ w \in \text{dom}(a) \text{ and } w \in \text{dom}(b).\ a(w)(b(w)) \mid a \in [\![\alpha]\!]_H, b \in [\![\beta]\!]_H \,\}$

- *Wh*-phrases are assumed to denote a non-singleton set of alternatives. We encode the sortal restriction as a presupposition.

(30) a. $[\![\text{who}]\!]_H = \{\, \lambda w_s\colon\ x \text{ is a person in } w.\ x \mid x \in D_e \,\}$

b. $[\![\text{Who left?}]\!]_H$

$$= \left\{ \lambda w_s.\ a(w)(b(w)) \;\middle|\; \begin{array}{l} b \in \{\, \lambda w_s\colon\ x \text{ is a person in } w.\ x \mid x \in D_e \,\}, \\ a \in \{\, \lambda w_s.\lambda x_e.\ x \text{ left in } w \,\} \end{array} \right\}$$

$$= \{\, \lambda w_s\colon\ x \text{ is a person in } w.\ x \text{ left in } w \mid x \in D_e \,\}$$

$$= \left\{ \begin{array}{l} \lambda w_s.\ j \text{ left in } w, \\ \lambda w_s.\ m \text{ left in } w, \\ \lambda w_s.\ b \text{ left in } w, \\ \ldots \end{array} \right\}$$

- Notice that the set in (30b) is not a partition, unlike in Hamblin (1958). It seems Hamblin has changed his mind.

> We shall need to regard 'who walks' as itself denoting a set, namely, the set whose members are propositions denoted by 'Mary walks', 'John walks', ... and so on for all individuals. Pragmatically speaking a question sets up a choice-situation between a set of propositions, namely, those proposition that count as answers to it. (Hamblin 1973:48)

- Polar questions can be accounted for by the operator in (31):

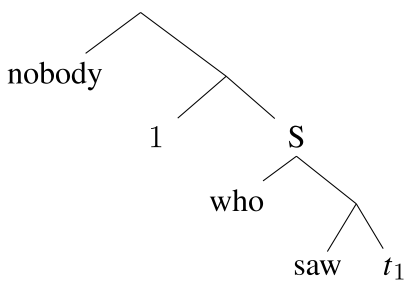
(31) $[\![?]\!]_H = \{\, \lambda w_s.\ \lambda p_{\langle s,t\rangle}.\ p(w) = 1,\ \lambda w_s.\ \lambda p_{\langle s,t\rangle}.\ p(w) = 0 \,\}$

- Singleton sets of propositions are statements; Non-singleton (non-empty) sets of propositions are questions.

2.3 The Problem of Abstraction

- Hamblin Semantics has a problem with abstraction/quantification (Shan 2004, Romero 2010, Charlow 2014).[3] Consider:

(32)



The denotation of *nobody* is as in (33).

(33) $[\![\text{nobody}]\!]_H = \{\, \lambda w_s.\lambda f_{\langle e,t\rangle}.\ \{\, y_e \mid f(y) = 1 \,\} = \varnothing \,\}$

In order to get the correct meaning, we want the sister of *nobody* to denote (34).

(34) $\{\, \lambda w_s.\lambda y_e.\ x \text{ saw } y \text{ in } w \mid x \in D_e \,\}$

Applying Hamblin Functional Application to (33) and (34), we'll get:

[3]Hamblin's (1973) original formulation also has a problem with quantifying-in, in sentences like *Nobody saw who?*.

(35) $\{\, \lambda w_s.\, \{\, y_e \mid x \text{ saw } y \text{ in } w \,\} = \varnothing \mid x \in D_e \,\}$

This is what we want.

- But there's no way to derive (34) compositionally.
  - S denotes a set of assignment dependent propositions (presuppositions are omitted).

    (36) $[\![\text{who saw } t_1]\!]^g_H = \{\, \lambda w_s.\, x \text{ saw g(1) in } w \mid x \in D_e \,\}$
  - How do we formulate the abstraction rule? The following formulation doesn't work:

    (37) *Hamblin Predicate Abstraction* (ver.1)
    $[\![i \text{ XP}]\!]^g_H = \{\, \lambda x_e.\, [\![\text{XP}]\!]^{g[i \mapsto x]}_H \,\}$

    (38) $[\![1 \text{ who saw } t_1]\!]^g_H$
    $= \{\, \lambda y_e. [\![\text{who saw } t_1]\!]^{g[1 \mapsto y]}_H \,\}$
    $= \{\, \lambda y_e.\, \{\, \lambda w_s.\, x \text{ saw } y \text{ in } w \mid x \in D_e \,\}\,\}$

    This is the wrong type.
  - The following is obviously wrong too:

    (39) *Hamblin Predicate Abstraction* (ver.2)
    $[\![i \text{ XP}]\!]^g_H = \lambda x_e.\, [\![\text{XP}]\!]^{g[i \mapsto x]}_H$

    (40) $[\![1 \text{ who saw } t_1]\!]^g_H$
    $= \lambda y_e. [\![\text{who saw } t_1]\!]^{g[1 \mapsto y]}_H$
    $= \lambda y_e.\, \{\, \lambda w_s.\, x \text{ saw } y \text{ in } w \mid x \in D_e \,\}$

    This is not even a set.
  - Kratzer & Shimoyama (2002) propose (41):

    (41) *Hamblin Predicate Abstraction* (ver.3)
    $[\![i \text{ XP}]\!]^g_H = \{\, f_{\langle s,\langle e,t\rangle\rangle} \mid \forall x_e[[\lambda w_s.\, f(w)(x)] \in [\![\text{XP}]\!]^{g[i \mapsto x]}_H] \,\}$

    (42) $[\![1 \text{ who saw } t_1]\!]^g_H$
    $= \{\, f_{\langle s,\langle e,t\rangle\rangle} \mid \forall y_e[[\lambda w_s.\, f(w)(y)] \in [\![\text{who saw } t_1]\!]^{g[i \mapsto y]}] \,\}$
    $= \{\, f_{\langle s,\langle e,t\rangle\rangle} \mid \forall y_e[[\lambda w_s.\, f(w)(y)] \in \{\, \lambda w_s.\, x \text{ saw } y \text{ in } w \mid x \in D_e \,\}] \,\}$

    The resulting set is of the correct type, but as Shan (2004) points out, the predicted meaning is incorrect. In particular, this set includes $f_{\langle s,\langle e,t\rangle\rangle}$ such that:

    $$[\lambda w_s.\, f(w)(\text{Ann})] = [\lambda w.\, \text{Andrew saw Ann in } w]$$
    $$[\lambda w_s.\, f(w)(\text{Bill})] = [\lambda w.\, \text{Becky saw Bob in } w]$$
    $$[\lambda w_s.\, f(w)(\text{Chris})] = [\lambda w.\, \text{Chloe saw Chris in } w]$$
    $$\ldots$$

    Then, the following answer is predicted to be felicitous, contrary to fact:

    (43) Who saw nobody?
    —#Andrew didn't see Ann, Becky didn't see Bob, Chloe didn't see Chris, etc.
- This problem arises in alternative semantics for focus as well.

3 Compositional Semantics 2: Karttunen (1977)

Karttunen (1977) proposes a more conservative extension of Montague Grammar (he uses PTQ). Again, we'll translate it into a more modern system.

3.1 Declarative Sentences

- We'll put the world parameter w on $[\![]\!]^{g,w}_K$ to make the composition easier to work out.
- Non-interrogative part of the semantics is as usual.

(44) a. $[\![\text{John}]\!]^{g,w}_K = j$
b. $[\![\text{walks}]\!]^{g,w}_K = [\lambda x_e.\ x \text{ walks in } w]$

These combine via Functional Application.

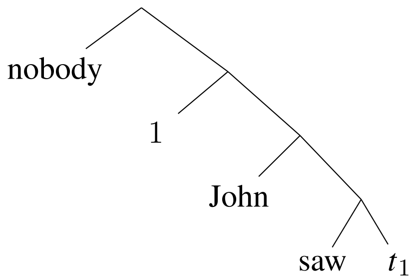
(45) *Extensional Functional Application*
If $[\![\alpha]\!]^{g,w}_K \in D_{\langle\sigma,\tau\rangle}$ and $[\![\beta]\!]^{g,w}_K \in D_\sigma$, then $[\![\alpha\ \beta]\!]^{g,w}_K = [\![\beta\ \alpha]\!]^{g,w}_K = [\![\alpha]\!]^{g,w}_K([\![\beta]\!]^{g,w}_K)$.

- Abstraction is not a problem.

(46) *Predicate Abstraction*
$[\![i\ \text{XP}]\!]^{g,w}_K = [\lambda x_e.\ [\![\text{XP}]\!]^{g[i\mapsto x]}_K]$

(47) $[\![\text{nobody}]\!]^{g,w}_K = [\lambda f_{\langle e,t\rangle}.\ \{\, x_e \mid f(x) = 1 \,\} = \varnothing]$

(48)



3.2 Polar Questions

A yes/no question is formed out of a declarative sentence by the question operator, which takes a proposition and creates a set containing it and its negation.

(49) $[\![?_{\text{yn}}]\!]^{g,w}_K = [\lambda p_{\langle s,t\rangle}.\ \{\, p,\ \lambda w'_s.\ p(w') = 0 \,\}]$

This combines with a declarative sentence via Intensional Functional Application.

(50) *Intensional Functional Application*
If $[\![\alpha]\!]^{g,w}_K \in D_{\langle\langle s,\sigma\rangle,\tau\rangle}$ and $[\![\beta]\!]^{g,w}_K \in D_\sigma$, then $[\![\alpha\ \beta]\!]^{g,w}_K = [\![\beta\ \alpha]\!]^{g,w}_K = [\![\alpha]\!]^{g,w}_K(\lambda w'_s.\ [\![\beta]\!]^{g,w'}_K)$.

3.3 *Wh*-Questions

A *wh*-question is formed by another question operator:

(51) $[\![?_{\text{wh}}]\!]^{g,w} = [\lambda p_{\langle s,t\rangle}.\ \lambda q_{\langle s,t\rangle}.\ p = q]$
(or in terms of sets: $[\![?_{\text{wh}}]\!]^{g,w} = [\lambda p_{\langle s,t\rangle}.\ \{\, p \,\}]$)

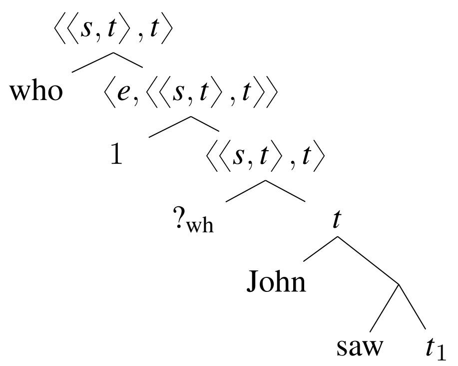
It's standard to assume that *wh*-phrases are existential quantifiers.

(52) $[\![\text{who}]\!]^{g,w} = [\lambda P_{\langle e,t\rangle}.\ \exists x_e[x \text{ is a person in } w \text{ and } P(x) = 1]]$

In order for the composition to work, we need the following compositional rule:

(53) *Interrogative Quantification*:
If $[\![\alpha]\!]^{g,w}_K \in D_{\langle et,t\rangle}$ and $[\![\beta]\!]^{g,w}_K \in D_{\langle e,\langle\langle s,t\rangle,t\rangle\rangle}$,
then $[\![\alpha\ \beta]\!]^{g,w}_K = \lambda p_{\langle s,t\rangle}.\ [\![\alpha]\!]^{g,w}_K([\lambda x_e.\ [\![\beta]\!]^{g,w}_K(x)(p) = 1])$.

(54)



(55) $[\![1\ ?_{\text{wh}}\ \text{John saw}\ t_1]\!]_K^{g,w} = \lambda x_e.\ \lambda q_{\langle s,t\rangle}.\ [q = \lambda w'_s.\ j \text{ saw } x \text{ in } w']$

(56) $[\![\text{who } 1\ ?_{\text{wh}}\ \text{John saw}\ t_1]\!]_K^{g,w}$
$= \lambda p_{\langle s,t\rangle}.\ [\![\text{who}]\!]^{g,w}([\lambda x_e.\ [\![1\ ?_{\text{wh}}\ \text{John saw}\ t_1]\!]_K^{g,w}(x)(p) = 1])$
$= \lambda p_{\langle s,t\rangle}.\ [\![\text{who}]\!]^{g,w}([\lambda x_e.\ [p = \lambda w'_s.\ j \text{ saw } x \text{ in } w']])$
$= \lambda p_{\langle s,t\rangle}.\ \exists x_e[x \text{ is a person in } w \text{ and } [p = \lambda w'_s.\ j \text{ saw } x \text{ in } w']]$
$\approx \{\, [\lambda w'_s.\ j \text{ saw } x \text{ in } w'] \mid x_e \text{ is a person in } w \,\}$

(In order to prevent indefinites like *somebody* to have a *wh*-meaning, we need to assume that indefinites cannot take scope above $?_{\text{wh}}$ for syntactic reasons)

Another possibility is to assign a more complex type to *wh*-phrases. This way, we can do dispense with Interrogative Quantification.

(57) $[\![\text{who}]\!]^{g,w} = [\lambda f_{\langle e,\langle\langle s,t\rangle,t\rangle\rangle}.\ \{\, p_{\langle s,t\rangle} \mid \exists x_e[x \text{ is a person in } w \text{ and } f(x)(p) = 1] \,\}]$

4 Further Topics

Embedded questions; Functional answers; *De re/de dicto* ambiguity; Multiple *wh*-questions

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