What Interrogative Sentences Refer to

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1 Introduction

In mainstream possible-worlds semantics (hereafter MPW), there have been two competing ideas about the extensions of questions (what interrogative utterances express): (1) the extension (at each world) is a *set* of propositions (in some theoretical sense, the answers); and (2) it is *a* proposition (theoretically, *the* answer). I will argue for a new, *functional* approach. The paper is organized as follows. In section 2, I review the most influential exemplars of the two established approaches, namely Karttunen 1977 (hereafter, K) and Groenendijk & Stokhof 1984/1989 (hereafter, G), identifying certain defects of both accounts, for which I suggest easy repairs. The repaired versions I will call, respectively, $K_{\pm}$ (plus-or-minus Karttunen) and G_{as} (asymmetric Groenendijk-Stokhof). In section 3, I propose the new, functional, approach, called F, and show how it combines the advantages of the earlier approaches while eliminating certain defects.

(1) **Five Theories of Questions**

a. Set-of-answer theories
   i. K (Karttunen 1977)
   ii. $K_{\pm}$ Plus-or-minus K, a proposed repair job on K

b. Partition (or single-answer) theories
   i. G (Groenendijk and Stokhof 1984/1989)
   ii. G_{as} Asymmetric G, a proposed repair job on G

c. F: the functional theory proposed here.

Moreover, the functional approach provides clear insight into the nature of the relationship between the earlier approaches.

Throughout, I assume that there is no semantic difference between root and embedded interrogatives, so that e.g. *does Fido bark?* and *whether Fido barks* mean the same thing. In this paper I mention only single (i.e. non-multiple) constituent questions; polar questions and multiple constituent questions are also treated in Pollard 2008a,b. For expository simplicity I ignore the difference between entities and individual concepts, since the issues in that connection are independent of the ones considered here.

2 A Fair Fight

I work within Ty2 (Gallin 1975), which has basic types s (worlds), t (truth values), and e (entities). I adopt the systematic abuse of language that speaks of a set when what is really intended is the characteristic function of the set. I use the following type abbreviations: π for s $\rightarrow$ t (propositions), κ for s $\rightarrow$ (π $\rightarrow$ t) (questions according to K), and γ for $s \rightarrow \pi$ (questions according to G; this is the (curried) type for binary (extensional) relations on worlds). I will call a proposition which is true at a world w a *w-fact*, and an entity which is a dog at w a *x-dog*.

I employ the following variables (possibly subscripted or primed): x, y, z : e; P, Q : e $\rightarrow \pi$; and $p, q : \pi$. Constants translating names are of type e; and VP and common noun meanings (e.g; dog', bark') have type e $\rightarrow \pi$. Additionally, not' abbreviates $\lambda_p \lambda_w \sim p(w)$.

(2) **Abbreviations**

a. some complex types

i. π abbreviates $s \rightarrow t$ (proposition)

ii. κ abbreviates $s \rightarrow (\pi \rightarrow t)$ (K's type for questions)

iii. γ abbreviates $s \rightarrow \pi$ (G's type for questions)

b. not' abbreviates $\lambda_p \lambda_w \sim p(w)$ (propositional negation).

Assuming the (so-called) interrogative pronoun *what* ranges over entities, consider how K and G respectively analyze:

(3) What barks?

According to G, at any world w, (3) refers to the set of worlds that agree with w on what the barkers are. This is called a *partition* analysis because questions are (curried) equivalence relations on the set of worlds, and the reference at each world is just that world's equivalence class. This analysis can be formalized by translating *what* by

(4) **Translation of Pronoun *what* in G**
what1g' $=_{\text{def}} \lambda_P \lambda_w \lambda_{w'} \forall_x (P(x)(w) = P(x)(w'))$

(5) The G reference at w of

(3) What barks?

is the set of worlds w' that agree with w about which entities bark.

Whereas on the K account, (3) refers to the set of w-facts of the form $\mathsf{bark'}(x)$. That analysis can be formalized by translating *what* by

(6) **Translation of Pronoun *what* in K**
$\mathsf{what1k'} =_{\text{def}} \lambda_P \lambda_w \lambda_q (q(w) \wedge \exists_x (q = P(x)))$

(7) The K reference at w of

(3) What barks?

is the set of w-facts each of which expresses, of some entity, that it barks.

Note the K account is at a disadvantage, since it only takes into account "positive atomic" answers (e.g. $\mathsf{bark'}(\mathsf{Rover'})$ and not negative ones (such as $\mathsf{not'}(\mathsf{bark'}(\mathsf{Felix'}))$), whereas the G notion of agreement between worlds takes into account both kinds. Intuitively, the problem is just that, if Felix is a cat, then *not Felix* should count as a true answer to (3). We can remove this disadvantage by revising the K account to translate interrogative pronoun *what* by

(8) **Translation of Pronoun *what* in K$_\pm$**
$\mathsf{what1k'}_\pm =_{\text{def}} \lambda_P \lambda_w \lambda_q (q(w) \wedge \exists_x ((q = P(x)) \vee (q = \mathsf{not'}(P(x)))))$

(9) The K$_\pm$ reference at w of

(3) What barks?

is the set of w-facts each of which expresses, of some entity, either that it barks or that it doesn't.

With this modification, there is now an interesting relationship between (as we will call it) the K$_\pm$ reference and the G reference: **the latter is precisely the set-theoretic intersection of the former**.

Now the set set-of-answers approach has the upper hand, in the sense that the G reference can be recovered from the K$_\pm$ reference but not conversely (since there are lots of ways to intersect sets to get a given set).

To make things more interesting, let's now look at constituent questions formed using the interrogative *determiner*, also spelled *what*:

(10) What dogs bark?

Now the K reference is as for (3), except now we only countenance x's that are w-dogs. We formalize this by translating the determiner *what* by

(11) **Translation of Determiner *what* in K**
$\textsf{what2k'} =_{\text{def}} \lambda_Q \lambda_P \lambda_w \lambda_q (q(w) \wedge \exists_x (Q(x) \wedge (q = P(x))))$

For example:

(12) The K reference at w of

(10) What dogs bark?

is the set of w-facts each of which expresses, for some w-dog that barks in w, that it barks.

However, as with the pronoun *what*, we revise this straightaway to the plus-or-minus version

(13) **Translation of Determiner *what* in $\mathbf{K}_{\pm}$**
$\textsf{what2k'}_{\pm} =_{\text{def}} \lambda_Q \lambda_P \lambda_w \lambda_q (q(w) \wedge \exists_x (Q(x) \wedge ((q = P(x)) \vee (q = \textsf{not'}(P(x))))))$

For example:

(14) The $K_{\pm}$ reference at w of

(10) What dogs bark?

is the set of w-facts each of which expresses, for some w-dog, either that it does or does not bark.

Either way, it is important to note the asymmetry between the first two arguments of the interrogative determiner:

(15) According to K, the following express *different* questions:

a. What dogs bark?
b. What barkers are dogs?

But according to G, they express the *same* question.

The G account can be formalized by translating the determiner *what* by

(16) **Translation of Determiner *what* in G**
$\textsf{what2g'} =_{\text{def}} \lambda_Q \lambda_P \lambda_w \lambda_{w'} \forall_x ((P(x)(w) \wedge Q(x)(w)) = (P(x)(w') \wedge Q(x)(w')))$

Note the symmetry between P and Q here: provably, what2g'$(P)(Q)$ = what2g'$(Q)(P)$. For example:

(17) The G reference at w of

(10) What dogs bark?

is the set of worlds w' that agree with w about which entities are dogs that bark.

For example, two worlds w and w' might agree, even though in w Fido is a nonbarking dog and in w' he is a barking cat. Something is wrong here. For example, suppose A asks B:

(18) A: What Democrats are liberal?
B: Well, there's Kennedy, Kerry, Lieberman ...
A: Lieberman?! He's not (even) a Democrat(H*+L)!
or
A: Lieberman?! He's not liberal (L* LH%)
but not
A: Lieberman?! He's not (even) liberal(H*+L)!

The point is that it matters *how* Lieberman fails to be a liberal Democrat.

To take another example, suppose A asks B:

(19) A: What mammals are carnivorous?
B: Well, lions, wolves ... but not cows ...
A: Go on.

Now compare:

(20) A: What mammals are carnivorous?
B: Well, lions, wolves ... but not crocodiles ...
A: *Go on. (unless A thinks crocodiles are mammals)

B's last answer misfired because the *way* that crocdiles fail to be carnivorous mammals is the *wrong* way for the question A asked. But then consider:

(21) A: What carnivores are mammals?
B: Well, lions, wolves ... but not crocodiles ...
A: Go on.

This time, crocodiles fail to be carnivorous mammals in the *right* way for the question A asked.

There is an easy repair to this problem: we say two worlds agree about which dogs bark if they agree, to begin with, on which entities are dogs, and moreover, for each of those, on whether it is a dog. Notice this is still a partition analysis, but a different one from the G analysis. Since it eliminates the symmetry problem with the G account, I call it the $\mathbf{G}_{\mathsf{as}}$ (**asymmetric G**) account. This is formalized by translating the determiner *what* by

(22) **Translation of Determiner *what* in $\mathbf{G}_{\mathsf{as}}$**
$\mathsf{what2g'}_{\mathsf{as}} =_{\text{def}} \lambda_Q \lambda_P \lambda_w \lambda_{w'} (\forall_x ((Q(x)(w) = Q(x)(w')) \wedge (Q(x)(w) \rightarrow ((P(x)(w) = P(x)(w'))))))$

For example:

(23) The G_{as} reference at w of

(10) What dogs bark?

is the set of worlds that agree with w about which entities are dogs, and, for each of them, about whether it barks.

(24) This is the same as the G reference of the conjoined interrogative

What entities are dogs? And which ones bark?

So the move from G to G_{as} introduces the desired asymmetry.

(25) G_{as} is also a partition theory, but the partition it gives is a refinement of the G partition.

(26) Unlike the situation with pronoun-*what*-interrogatives, the G_{as} reference at w of

(10) What dogs bark?

is no longer the intersection of the $\mathrm{K}_{\pm}$ one.

That is because the latter can also contain worlds that disagree with w about which entities are dogs.

3 Questions as Functions to Propositions

The functional approach to questions proposed here, which we call F, can be pretty well summed up by the following translation for the interrogative determiner *what*:

(27) **Translation of Determiner *what* in F**
what2' $=_{\text{def}} \lambda_Q \lambda_P \lambda_w \lambda_x \lambda_q (Q(x)(w) \wedge q(w) \wedge ((q = P(x)) \vee (q =$ not'$(P(x))))))$

For example:

(28) The F reference at w of

(10) What dogs bark?

is the (curried form of the characteristic function of) the function that maps each w-dog to the proposition that it barks or its denial, whichever is a w-fact.

Intuitively: for each dog, does it bark?

(29) **F Explicates the Relation between $\mathbf{K}_{\pm}$ and $\mathbf{G}_{\mathsf{as}}$**
For any two properties P and Q:

a. the F-sense of what'$_2(P)(Q)$ is a function F that maps each world w to a function from the w-P's to propositions;

b. the G_{as}-sense of what'$_2(P)(Q)$ is precisely the *equivalence relation induced by* F, i.e. $\lambda_w \lambda_{w'}(F(w) = F(w'))$; and

c. for each world w, the $\mathrm{K}_{\pm}$-reference of what'$_2(P)(Q)$ is precisely the *range* of the function $F(w)$.

(30) **Conclusion: F is Better than G or K**

a. G_{as} repairs the undesirable symmetry of G.

b. $\mathrm{K}_{\pm}$ repairs the positive bias of K.

c. F is more fine-grained than either, in the sense that the senses and references they provide are obtainable by standard constructions (induced equivalence and range) from the ones F provides.

d. But the reverse is not true: both construction lose information (different functions can induce the same equivalence relation or have the same range).

e. F embodies the virtues of both G and K while incorporating improvements to both.

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