Generalized Quantifiers and *in situ*-Interpretation

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We investigate problems with the interpretation of standard Generalized Quantifiers (GQs) in the Choice Function (CF) approach and propose a refinement to *minimal* CFs, which handles standard GQs correctly. This refined version is then shown to be equivalent to the *Double Scope (DS) approach* (Endriss&Haida 2001) in extensional contexts only. This makes plausible, that the *in situ*-interpretation of the CF approach runs into problems (Geurts 2000), which the DS does not have due to its dislocation of the GQ. To investigate the handling of standard GQs in the CF approach we consider the following example:

(1) If three relatives of mine die, I will inherit a fortune.

The Choice Function representation of the wide scope reading of (1) is

(2) $\exists f.\ CF(f) \wedge$ IF $\mathbf{Dist}(f(3rel))(die)$ THEN I will inherit a fortune.

where **Dist** is the distribution operator $\lambda P.\lambda Q.\forall x.P(x) \rightarrow Q(x)$. This representation leads to wrong truth conditions if *3rel* denotes the 'standard' generalized quantifier (GQ)

(3) $3rel \equiv \lambda Q.|\ relatives\_of\_mine \cap Q\ | = 3$

because the CF is not committed to choosing only elements of the restrictor set. The proposed solution to this problem is a deviation from the standard GQ semantic (3) towards the following (cf. (Reinhart 1997)):

(4) $3rel' \equiv \lambda Q.\ Q \subseteq relatives\_of\_mine \wedge |Q| = 3$

Substituting (4) for (3) in (2) yields the truth conditionally correct representation, since the CF is forced to select only sets containing exactly three relatives by definition. But using (4), one can get the same result without the use of Choice Functions as is shown in the following representation:

(5) $\exists P.\ 3rel'(P) \wedge$ IF $\mathbf{Dist}(P)(die)$ THEN I will inherit a fortune.

By making use of the GQ semantics in (4) Choice Functions become superfluous to derive wide scope interpretations. A different approach would be to derive the GQ semantics from the 'standard' ones. This can be achieved by constructing the *minimal witness sets* of a standard GQ using the following operator

(6) $\mathbf{M} \equiv \lambda \mathrm{R}.\lambda P.\ \mathrm{R}(P) \wedge \mathbf{min}(P, \mathrm{R})$,

where the **min**-operator is defined as

(7) $\mathbf{min} \equiv \lambda \mathrm{R}.\lambda P.\ \neg\exists X.\ \mathrm{R}(X) \wedge X \subset P$

Applying **M** to a standard GQ yields a generalized quantifier that exists of the minimal witness sets of this GQ, e.g. $\mathbf{M}(3rel) = 3rel'$. We can now account for the narrow scope reading of (1) by using the standard GQ *3rel* and for the wide scope reading by using the derived GQ $\mathbf{M}(3rel)$ as follows:

(8) IF $3rel(die)$ THEN I will inherit a fortune.
(9) $\exists P.\ \mathbf{M}(3rel)(P) \wedge$ IF $\mathbf{Dist}(P)(die)$ THEN I will inherit a fortune.

This mechanism explains narrow scope readings by using the standard GQ semantics. The wide scope readings are derived by dislocating the GQ and minimizing and distributing it via **M** and

Dist respectively. The idea of different scope positions for the collective and distributive part of a quantifier has been developed in (Szabolcsi 1997). It has been elaborated within a QR mechanism in the *Double Scope* (DS) approach (Endriss&Haida 2001). The DS approach has been shown to account for an even broader range of phenomena than the CF approach, e.g. the non-distributive *de re*-readings of strong quantifiers (such as in *Someone believes that every politician is corrupt*), unexpected anaphoric references (such as in *Yesterday, three students were at the party. *He/They had fun.*) and the classification of quantifiers into those, which can take wide scope and those, which cannot.

In correspondence with the dislocation of a GQ and the application of **M**, the minimization can also be incorporated into the CF approach. We propose a refinement of the Choice Function predicate *CF* to $CF_{\min}$, the *minimal Choice Function* predicate:

(10) $CF_{\min}(f) \equiv CF(f) \wedge \forall X.\ \mathbf{min}(f(X), X).$

where *f* is of type $\langle\langle\langle e, t\rangle, t\rangle, \langle e, t\rangle\rangle$. That is, we require the CF to choose a minimal witness set from its GQ argument. Using this definition instead of the standard one in (2), the wide scope reading of (1) can be derived by using the standard GQ semantics *3rel*. In order to compare the CF and DS approach, we may derive the following abstract representations for wide scope readings in general, where $\varphi[X]$ denotes a formula containing *X*, e.g. $\varphi[X] = \mathbf{Dist}(X)(die) \rightarrow$ I will inherit a fortune.

(11) $\exists f.\ CF_{\min}(f) \wedge \varphi[f(G)]$ (CF-min approach)

(12) $\exists P.\ G(P) \wedge \mathbf{min}(P, G) \wedge \varphi[P]$ (DS approach)

The GQ argument *G* appears inside φ in the CF-min approach (i.e. the GQ remains *in situ*), whereas it does not appear inside φ in the DS approach (as the GQ is dislocated). Now consider the interpretation of (11) and (12) in the same model *M*. If φ is an extensional context, the denotations of *G* in (11) and (12) are identical. In this case, (11) and (12) are equivalent, since the existence of a function, that selects a minimal witness set of *G* implies the existence of this set and vice versa. However, if φ is an intensional context, the denotation of *G* in (11) might differ from that in (12) as *G* is interpreted *in situ* – i.e. inside of φ – in (11) and outside of φ in (12). Thus we conclude that the DS and the CF-min approach yield equivalent representations in extensional contexts and they might differ in intensional ones. This makes plausible that the DS approach can account for the same wide scope readings as the CF approach without running into the same *in situ* problems (Geurts 2000).

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