Structured Contexts for Natural Language Interpretation

Part 1: Contextually Encoded Quantificational Dependencies

Adrian Brasoveanu
Stanford University

Semantics Workshop, Rutgers Center for Cognitive Science – October 6, 2007

- the main theme of the presentation: we need a richer, structured notion of context for natural language interpretation – more structure both within and across contexts;
- we need more structure *within* contexts to capture the way in which information about quantificational dependencies is passed across sentential boundaries, for example in discourses involving quantificational subordination (this is Part 1 – Adrian);
- we need more structure *across* contexts to capture reference in discourses involving multiple agents, hence multiple contexts that share, in some sense, the same referential intention (this is Part 2 – Sam).

The Phenomenon: Anaphora to Quantificational Dependencies

- main goal: argue that (*i*) quantificational subordination and (*ii*) exceptional wide scope are just two aspects of the same phenomenon – anaphora to quantificational dependencies;
- let us examine them in turn ...

Quantificational Subordination

- consider the contrast between the following two discourses (from Karttunen 1976[1]):

  1. **a.** Harvey courts a^{u} girl at every$^{u'}$ convention. **b.** She$_{u}$ is very pretty.
  2. **a.** Harvey courts a^{u} girl at every$^{u'}$ convention. **b.** She$_{u}$ always$_{u'}$ comes to the banquet with him. [**c.** The$_{u}$ girl is usually$_{u'}$ also very pretty.]

- the initial sentence *Harvey courts a girl at every convention* is ambiguous between two quantifier scopings: *every* >> *a* (narrow-scope indefinite) and *a* >> *every* (wide-scope indefinite);
- but the first discourse as a whole allows only for the wide-scope indefinite reading: there is a girl such that Harvey courts her at every convention and this girl is very pretty;

[1] For more discussion of quantificational subordination and telescoping, see Roberts (1987), Poesio & Zucchi (1992) and Wang et al. (2006) among others.

- in contrast, the second discourse also allows for the narrow-scope indefinite reading: every convention is such that Harvey courts a girl at that convention and such that the girl that Harvey courts at that convention comes to the banquet (of that convention) with him.

INDEXATION:

- superscripts - on antecedents; subscripts - on anaphors;
- indices: discourse referents (dref's) introduced / retrieved by particular lexical items;
- determiners and not whole DP's introduce new dref's because all the non-determiner elements in a DP can also be part of definite DP's, which do not (necessarily) introduce new dref's.

DISCOURSE (1) RAISES THE FOLLOWING QUESTION:

- how can we capture the fact that a *singular anaphoric pronoun* in sentence (1b) can interact with and disambiguate *quantifier scopings*[2] in sentence (1a)?
- the discourse in (3) below, where the plural pronoun *they* selects the narrow-scope indefinite reading, shows that number morphology on the pronoun is crucial:

3. **a.** Harvey courts a^{u} girl at $\text{every}^{u'}$ convention. **b.** They_{u} are very pretty.

DISCOURSE (2) RAISES THE FOLLOWING QUESTIONS:

- why is it that adding an adverb of quantification, i.e. *always/usually*, makes both readings of sentence (2a) available?
- w.r.t. the newly available reading of sentence (2a) (i.e., *every convention>>a girl*): how can we capture the intuition that the singular pronoun *she* and the adverb *always* in (2b) elaborate on the quantificational dependency between conventions and girls introduced in (2a)?
- that is, how can we capture the intuition that we have simultaneous anaphora to: (*i*) the two quantifier domains and (*ii*) the quantificational dependency between them?

WHY GIVE A (PARTLY) SEMANTIC ACCOUNT - AND NOT AN EXCLUSIVELY PRAGMATIC ONE - FOR SUCH *cross-sentential* PHENOMENA?

- because the same kind of anaphora to dependencies occurs intra-sententially – see for example the mixed weak & strong donkey sentence in (4) below[3] ...

4. Every^{u} person who buys $\text{a}^{u'}$ book on amazon.com and has $\text{a}^{u''}$ credit card uses $\text{it}_{u''}$ ($\text{the}_{u''}$ card) to pay for $\text{it}_{u'}$ ($\text{the}_{u'}$ book).

- ... and whatever is part of the recursive definition of truth and satisfaction is plausibly part of semantics (see for example the 'dual' semantic & pragmatic status of characters and utterance contexts in Kaplan 1989);

[2] To see that it is indeed quantifier scopings that are disambiguated, substitute $\textit{exactly one}^{u}$ *girl* for a^{u} *girl* in (1a); this yields two truth-conditionally independent scopings: (*i*) *exactly one girl>>every convention*, which is true in a situation in which Harvey courts more than one girl per convention, but there is exactly one (e.g. Faye Dunaway) that he never fails to court, and (*ii*) *every convention>>exactly one girl*.

[3] See Brasoveanu (2007) for more details.

- moreover, the phenomenon instantiated by (1) and (2) is as much intra-sentential as it is cross-sentential – there are four separate components that come together to yield the contrast between (1) and (2), namely: (*i*) the generalized quantifier *every convention*, (*ii*) the indefinite *a girl*, (*iii*) the singular number morphology on the pronoun *she* and (*iv*) the adverb of quantification *always/usually*;
- to derive the intuitively correct interpretations for (1) and (2), we have to attend to both the cross-sentential connections *a girl–she* and *every convention–always/usually* and the intra-sentential interactions *every convention–a girl* and *always–she*.

The Proposal: Encoding Quantificational Dependencies in Plural Info States

- the cross-sentential interaction between quantifier scope and anaphora is captured by means of a new compositional dynamic system couched in classical type logic which, following van den Berg (1996) (among others) models information states as *sets* of variable assignments;
- such a plural info state can be represented as a matrix with variable assignments – i.e., sequences of individuals – as rows;
- a plural info state is two-dimenional and encodes two kinds of information: (*i*) values – the columns of the matrix store sets of objects, and (*ii*) structure – each row of the matrix encodes a correlation / dependency between the objects stored in it;

Info State I	...	u	u'	...
i_1	...	x_1 (i.e. ui_1)	y_1 (i.e. $u'i_1$)	...
i_2	...	x_2 (i.e. ui_2)	y_2 (i.e. $u'i_2$)	...
i_3	...	x_3 (i.e. ui_3)	y_3 (i.e. $u'i_3$)	...
...	...	...	...	...
Quantifier domains (sets) are stored columnwise: $\{x_1, x_2, x_3, \dots\}$, $\{y_1, y_2, y_3, \dots\}$		**Quantifier dependencies** (relations) are stored rowwise: $\{(x_1, y_1), (x_2, y_2), (x_3, y_3), \dots\}$		

- the fact that information states encode both quantifier domains (i.e. values) and quantificational dependencies (i.e. structure) enables us to capture the cross-sentential interaction between quantifier scope and anaphora exhibited by the above quantificational subordination discourses – because we can now pass information about both quantifier domains and quantificational dependencies across sentential/clausal boundaries;
- given that the dynamic system is couched in classical type logic, compositionality at subclausal level (Montague-style) follows automatically.

Quantificational Subordination and Plural Info States

THE MEANING OF QUANTIFIERS:

- selective generalized determiners like *every* store two things in a plural info state: (*i*) the restrictor and nuclear scope sets of individuals that are introduced and related by the determiner; (*ii*) the quantificational dependencies between the individuals in the restrictor / nuclear scope set and any other quantifiers / indefinites in the restrictor / nuclear scope of the quantification;
- for example: between *every convention* in (1a/2a) and the indefinite *a girl* in its nuclear scope;
- for example: between *every person* in (4) and the indefinites *a book* and *a credit card* in its restrictor;
- information about both sets of individuals and dependencies between them is therefore available for subsequent anaphoric retrieval;
- for example, *always* and *she* in (2b) are simultaneously anaphoric to both the sets of conventions and girls and the dependency between these sets introduced in (2a);

THE MEANING OF SINGULAR ANAPHORS:

- we also need a suitable meaning for singular number morphology on pronouns like she_u in (1b/2b) above: I take singular number morphology to contribute a contextually-relativized uniqueness requirement;
- for example: she_u in (1b/2b) requires the set of u-individuals introduced by the indefinite a^u *girl* to be a singleton;

CROSS-SENTENTIAL INTERACTIONS BETWEEN QUANTIFIERS AND SINGULAR ANAPHORS:

- if the indefinite a^u *girl* has narrow scope relative to *every convention*, the singleton requirement contributed by she_u applies to the set of girls that are courted by Harvey at some convention or other;
- requiring this set to be a singleton boils down to removing from consideration all the plural info states that would satisfy the narrow-scope indefinite reading *every convention*$>>a^u$ *girl*, but not the wide-scope reading a^u *girl*$>>$*every convention*;
- thus, we capture the intuition that, irrespective of which quantifier scoping we assume for sentence (1a), any plural info state obtained after a successful update with sentence (1b) is bound to satisfy the representation in which the indefinite a^u *girl* takes wide scope;

INTRA-SENTENTIAL INTERACTIONS BETWEEN QUANTIFIERS AND SINGULAR ANAPHORS:

- in discourse (2), however, the adverb of quantification *always* in (2b), which is anaphoric to the nuclear scope set introduced by *every convention*, can take scope above the singular pronoun she_u – in which case it 'breaks' the input plural info state storing all the conventions into smaller sub-states, each storing a particular convention;
- consequently, the singleton requirement contributed by she_u is enforced locally, relative to each of these sub-states, and not globally, relative to the whole input info state, so we end up requiring the courted girl to be unique *per convention* and not across the board.

Exceptional Wide Scope as Quantificational Subordination

- anaphora to quantificational dependencies enables us to provide a novel solution to the problem of exceptional scope (ES) of (in)definites, first noticed in Farkas (1981) and Fodor & Sag (1982)[4];
- the ES cases we are interested in – the widest and the intermediate scope readings of sentence (5), given below in first order translations:

5. Every$^{u \sqsubseteq r}$ student of mine read every$^{u' \sqsubseteq r'}$ poem that a$^{u'' \sqsubseteq r''}$ famous Romanian poet wrote before World War II.
6. Narrowest scope (NS) indefinite:
   $\forall x(student.o.m(x) \rightarrow \forall y(poem(y) \wedge \exists z(r.poet(z) \wedge write(z,y)) \rightarrow read(x,y)))$
7. **a.** Intermediate scope (IS) indefinite:
   $\forall x(student.o.m(x) \rightarrow \exists z(r.poet(z) \wedge \forall y(poem(y) \wedge write(z,y) \rightarrow read(x,y))))$
   b. Context for the IS reading:
   Every^{r} student chose a$^{r''}$ (different$_{r,r''}$) poet and read every$^{r'}$ poem written by him.
8. **a.** Widest scope (WS) indefinite:
   $\exists z(r.poet(z) \wedge \forall x(student.o.m(x) \rightarrow \forall y(poem(y) \wedge write(z,y) \rightarrow read(x,y))))$
   b. Context for the WS reading:
   Every^{r} student chose a$^{r''}$ poet – the same$_{r,r''}$ poet – and read every$^{r'}$ poem written by him.

- the main idea: the ES readings are instances of quantificational subordination – since the availability of such readings is crucially dependent on the context relative to which (5) is interpreted;
- thus, we follow Farkas (1997) in taking scope to be essentially discoursal; the syntax/semantics interface underdetermines scopal relations – it only specifies "when an expression *may* be in the scope of another, but not when it *must* be in its scope" (p. 184);
- the IS reading is available when (5) is interpreted in the context provided by (7b), which, in fact, forces an IS interpretation;
- similarly, the WS reading is the only available one in the discourse context provided by (8b).

The basic account of exceptional wide scope

- ES readings are available when sentence (5) is anaphoric to particular kinds of quantifier domains and quantificational dependencies introduced in the previous discourse (or accommodated if there is no previous discourse);
- that is, the two *every* determiners and the indefinite article in (5) further elaborate on the sets of individuals and the correlations between them introduced in (7b) and (8b);
- the account relies on the independently motivated assumption that quantifier domains are always contextually restricted;

[4]This novel analysis of exceptional wide scope is the result of joint work with Donka Farkas – see Brasoveanu & Farkas (2007).

- under this analysis, (in)definites are not ambiguous between their ordinary existential meanings and choice-/Skolem-function based meanings and there is no need to resort to movement, special storage mechanisms, choice function variables or bound implicit arguments to derive the ES readings.

Exceptional wide scope and plural info states

- unlike the tradition inaugurated in Fodor & Sag (1982) and varied upon in Reinhart (1997) and Kratzer (1998), (in)definites are not taken to be ambiguous between their ordinary existential meanings and choice-/Skolem-function based meanings;
- there is no need to resort to special scoping mechanisms (as in Abusch 1994) or to posit special choice-functional variables (as in Winter 1997);
- the account builds on the insight in Schwarzschild (2002) that contextual restrictions on quantifier domains play a crucial role in the genesis of ES readings – without, however, relying on *singleton* quantifier domain restrictions or implicit arguments (the latter are crucial for the derivation of IS readings in Schwarzschild 2002);
- the IS interpretation arises because of the presence in the input discourse context of a function pairing r-students and r''-Romanian poets that rules out the possibility of co-variation between the quantifier $every^{u' \sqsubseteq r'}$ *poem* and the indefinite $a^{u'' \sqsubseteq r''}$ *poet* in sentence (5);
- this function emerges (without any additional stipulation) as a result of the update contributed by sentence (7b);
- the WS reading arises because the value of the dref r'' is constant, thereby ruling out any possibility of co-variation whatsoever;
- finally, the NS reading arises by default, when there are no special contextual restrictions on the indefinite article and the *every* determiners in sentence (5).

Extensions: Modal Subordination and Belief Reports

- the system is straightforwardly extended to account for modal subordination (we just need to add dref's p, p' etc. for possible worlds):

  9. **a.** A^u wolf might^p come in. **b.** It$_u$ would$_p$ eat Harvey first.
     (based on an example in Roberts 1989[5])

- thus, we capture the anaphoric and quantificational parallels between the individual and modal domains argued for in Stone (1999), Bittner (2001) and Schlenker (2005) (among others), building on Partee (1973, 1984);
- plural info states are needed to capture modal subordination across attitude reports, e.g.:

  10. John thinks^p that he will$_p$ catch a^u fish and he hopes$^{p'}_p$ I will$_{p'}$ grill it$_u$ tonight.
      (Heim 1990)

[5]For more discussion of modal subordination, see also Frank (1996), Frank & Kamp (1997), Geurts (1999), Stone (1999) and McCready & Asher (2006) among others.

- plural info states also enable us to capture modal subordination across *de se* attitude reports[6], where we need to pass information about centered worlds across sentential boundaries – as in (11) below:

  11. John believes$^{p,u^{self}}$ that his$_{u^{self}}$ pants are$_p$ on fire and he hopes$^{p',u^{self\prime}}_{p,u^{self}}$ that he$_{u^{self\prime}}$ will$_{p'}$ find a fire extinguisher some time soon.

- centered worlds: pairs / dependencies of the form (w, x^{self}), where w is an attitude internal world (a belief world, a hope world etc.) and x^{self}, the center of world w, is the individual that the attitude holder takes herself to be in w;
- centered worlds are represented by means of a modal dref p and an individual dref u^{self} and the rows in a plural info state store the dependencies between worlds and their centers (note that we allow the same world to be associated with multiple centers, as argued for in Lewis 1979).

References

[1] Abusch, D. (1994). The Scope of Indefinites. In *Natural Language Semantics* 2.2, 83-135.
[2] Abusch, D. (1997). Sequence of Tense and Temporal De Re. In *Linguistics and Philosophy* 20, 1-50.
[3] Anand, P. (2006). *De de se*. PhD dissertation, MIT.
[4] van den Berg, M. (1996). *Some aspects of the Internal Structure of Discourse. The Dynamics of Nominal Anaphora*. PhD dissertation, University of Amsterdam.
[5] Bittner, M. (2001). Topical Referents for Individuals and Possibilities. In *Proceedings of SALT 11*, Hastings, R. et al (eds.), CLC, Cornell University, 36-55.
[6] Brasoveanu, A. (2007). *Structured Nominal and Modal Reference*. PhD dissertation, Rutgers University.
[7] Brasoveanu, A. & D.F. Farkas (2007). Exceptional Wide Scope as Anaphora to Quantificational Dependencies. Stanford University and UC Santa Cruz, ms.
[8] Chierchia, G. 1989. Anaphora and Attitudes De Se. In *Semantics and Contextual Expression*, R. Bartsch et al. (eds.), Dordrecht: Foris.
[9] Cresswell, M.J. & A. von Stechow (1982). De Re Belief Generalized. In *Linguistics and Philosophy* 5, 503-535.
[10] Farkas, D.F. (1981). Quantifier Scope and Syntactic Islands. In the *Proceedings of CLS 7*, R. Hendrik et al (eds.), CLC, Cornell University, 59-66.
[11] Farkas, D.F. (1997). Evaluation Indices and Scope. In *Ways of Scope Taking*, A. Szabolcsi (ed.), Dordrecht: Kluwer, 183-215.
[12] Fodor, J.D. & I. Sag (1982). Referential and Quantificational Indefinites. In *Linguistics and Philosophy* 5, 355-398.
[13] Frank, A. (1996). *Context Dependence in Modal Constructions*. PhD dissertation, University of Stuttgart.
[14] Frank, A. & H. Kamp (1997). On Context Dependence in Modal Constructions. In *Proceedings of SALT 7*, Stanford University.
[15] Geurts, B. (1999). *Presuppositions and Pronouns*. Amsterdam: Elsevier; revised version of Geurts, B. 1995, *Presupposing*, PhD dissertation, University of Stuttgart.
[16] Heim, I. (1982). *The Semantics of Definite and Indefinite Noun Phrases*. PhD dissertation, UMass Amherst.
[17] Heim, I. (1990). E-Type Pronouns and Donkey Anaphora. In *Linguistics and Philosophy* 13, 137-177.

[6] For more discussion of *de se* reports, see Lewis (1979), Creswell & von Stechow (1982), Kaplan (1989), Chierchia (1989), Abusch (1997), Schlenker (1999) and Anand (2006) among others.

[18] Kamp, H. (1981). A theory of truth and semantic representation. In *Formal Methods in the Study of Language. Part 1*, Groenendijk, J., T. Janssen & M. Stokhof (eds.), Mathematical Center, Amsterdam, 277-322.
[19] Kratzer, A. (1998). Scope or Pseudo-Scope: Are There Wide-Scope Indefinites?. In *Events in Grammar*, S. Rothstein (ed.), Dordrecht: Kluwer, 163-196.
[20] Kaplan, D. (1989). Demonstratives. In *Themes from Kaplan*, Almog, Perry & Wettstein (eds.), Oxford: Oxford University Press, 481-563.
[21] Karttunen, L. (1976). Discourse Referents. In *Syntax and Semantics, Volume 7: Notes from the Linguistic Underground*, J.D. McCawley (ed.), New York: Academic Press, 363-385.
[22] Lewis, D. (1975). Adverbs of Quantification. In *Formal Semantics of Natural Language*, E. Keenan (ed.), Cambridge: Cambridge University Press, 3-15.
[23] Lewis, D. (1979). Attitudes De Dicto and De Se. In *The Philosophical Review* 88:4, 513-543.
[24] McCready, E. & N. Asher (2006). Modal Subordination in Japanese: Dynamics and Evidentiality. In *Penn Working Papers in Linguistics*.
[25] Montague, R. (1974). The Proper Treatment of Quantification in Ordinary English. In *Formal Philosophy. Selected Papers of Richard Montague*, R. Thomason (ed.), New Haven: Yale University Press, 247-270.
[26] Partee, B. (1973). Some Structural Analogies between Tenses and Pronouns in English. In *Journal of Philosophy* 70, 601-609.
[27] Partee, B. (1984). Nominal and Temporal Anaphora. In *Linguistics and Philosophy* 7, 243-286.
[28] Poesio, M. & A. Zucchi 1992. On Telescoping. In *Proceedings of SALT 2*, C. Barker D. Dowty (eds.).
[29] Reinhart, T. (1997). Quantifier Scope: How Labor is Divided between QR and Choice Functions. In *Linguistics and Philosophy* 20, 335-397.
[30] Roberts, C. (1987). *Modal Subordination, Anaphora and Distributivity*. PhD dissertation, UMass Amherst.
[31] Roberts, C. (1989). Modal Subordination and Pronominal Anaphora in Discourse. In *Linguistics and Philosophy* 12, 683-721.
[32] Schlenker, P. (1999). *Propositional Attitudes and Indexicality: A Cross-Categorial Approach*. PhD dissertation, MIT.
[33] Schlenker, P. (2005). Ontological Symmetry in Language: A Brief Manifesto. To appear in *Mind & Language*.
[34] Schwarzschild, R. (2002). Singleton Indefinites. In *Journal of Semantics* 19.3, 289-314.
[35] Stone, M. (1999). *Reference to Possible Worlds*, RuCCS Report 49, Rutgers University, New Brunswick.
[36] Wang, L., E. McCready & N. Asher (2006). Information Dependency in Quantificational Subordination. In *Where Semantics Meets Pragmatics*, K. Turner & K. von Heusinger (eds.), Elsevier (forthcoming).
[37] Winter, Y. (1997). Choice Functions and the Scopal Semantics of Indefinites. In *Linguistics and Philosophy* 20, 399-467.