# Propositions, Questions, and Adjectives: a rich type theoretic approach

**Jonathan Ginzburg**
CLILLAC-ARP
& Laboratoire d'Excellence (LabEx)–Empirical Foundations of Linguistics
Université Paris-Diderot, Sorbonne Paris-Cité
yonatan.ginzburg@univ-paris-diderot.fr

**Robin Cooper**
University of Gothenburg
cooper@ling.gu.se

**Tim Fernando**
Trinity College, Dublin
Tim.Fernando@cs.tcd.ie

## Abstract

We consider how to develop types corresponding to propositions and questions. Starting with the conception of *Propositions as Types*, we consider two empirical challenges for this doctrine. The first relates to the putative need for a single type encompassing questions and propositions in order to deal with Boolean operations. The second relates to adjectival modification of question and propositional entities. We partly defuse the Boolean challenge by showing that the data actually argue against a single type covering questions and propositions. We show that by analyzing both propositions and questions as records within Type Theory with Records (TTR), we can define Boolean operations over these distinct semantic types. We account for the adjectival challenge by embedding the record types defined to deal with Boolean operations within a theory of semantic frames formulated within TTR.

## 1 Introduction

*Propositions as types* has long been viewed as a *sine qua non* of many a type theoretic approach to semantics (see e.g., the seminal work of (Ranta, 1994)). Although this has lead to a variety of very elegant formal accounts, one can question its appropriateness as a type for NL propositions—the denotata of declaratives and of nouns such as 'claim' and the objects of assertion. One immediate issue concerns semantic selection—how to specify the semantic types of predicates such as 'believe' and 'assert' so that they will not select for e.g., the type of biscuits or the type of natural numbers, given their inappropriateness as objects of belief or assertion. However, one resolves this issue, we point to two other significant challenges:

1. Recently there have been a number of proposals that questions and propositions are of a single ontological category (see (Nelken and Francez, 2002; Nelken and Shan, 2006)) and most influentially work in Inquisitive Semantics (IS) (Groenendijk and Roelofsen, 2009). A significant argument for this is examples like (1), where propositions and questions can apparently be combined by boolean connectives.

   (1) If Kim is not available, who should we ask to give the talk?

   In Inquisitive Semantics, such data are handled by postulating a common type for questions and propositions as sets of sets of worlds. It is not *a priori* clear how *propositions as types* can account for such cases.

2. Adjectives pose a challenge to all existing theories of questions and propositions, possible worlds based (e.g., (Karttunen, 1977; Groenendijk and Stokhof, 1997; Groenendijk and Roelofsen, 2009), or type theoretic, as in Type Theory with Records (TTR, (Cooper, 2012; Ginzburg, 2012)). There is nothing in the semantic entity associated with a polar question as in (2), be it a two cell partition (as in partition semantics) or a constant function from records into propositions (as in Ginzburg 2012) that will allow it to distinguish *difficult* from *easy* questions. Similarly, since the denotation of a question is not conceived as an event, this denotation is not appropriate for the adjective *quick*:

   (2) A: I have a quick question: is every number above 2 the sum of two primes?

   B: That's a difficult question.



*Proceedings of the EACL 2014 Workshop on Type Theory and Natural Language Semantics (TTNLS)*, pages 89–96,
Gothenburg, Sweden, April 26-30 2014. 

And yet, these two distinct classes of adjectives can simultaneously apply to a question together with 'resolved', a target of all existing theories of questions, as in (3), calling for a unified notion of question:

(3) The quick question you just posed is difficult and for the moment unresolved.

'Difficult' and 'silly' apply to both propositional and question entities, suggesting the need for a unified meaning for the adjective and a means of specifying its selection so that it can modify both questions and propositions:

(4) a. *silly claim* (a claim silly to assert)
b. *silly question* (a question silly to ask);
c. *difficult claim* (a claim difficult to prove)

In this paper we partly defuse the Boolean challenge by showing that the data actually argue against a single type covering questions and propositions. We show that by analyzing both propositions and questions as records within TTR, we can define Boolean operations over these distinct semantic types. We then propose to deal with the adjectival challenge by embedding the types initially defined within a theory of semantic frames (Fillmore, 1985; Pustejovsky, 1995) formulated within TTR.

## 2 Questions and Propositions: a unified semantic type?

Although there has been a recent trend to assume a commonality of type for questions and propositions, both Hamblin and Karttunen gave arguments for distinguishing questions as an ontological category from propositions—(Hamblin, 1958) pointing out that interrogatives lack truth values; to which one can add their incompatibility with a wider scoping alethic modality:

(5) a. It's true/false who came yesterday
b. # Necessarily, who will leave tomorrow?

Whereas (Karttunen, 1977) pointed to the existence of predicates that select interrogatives, but not for declaratives and vice versa:

(6) a. Bo asked/investigated/wondered/# believed /# claimed who came yesterday.
b. Bo # asked/# investigated/# wondered/ believed /claimed that Mary came yesterday.

We argue that although speech acts involving questions and propositions can be combined by boolean connectives they are not closed under boolean operations. Furthermore, we argue that the propositions and questions *qua* semantic objects cannot be combined by boolean operations at all. This, together with the examples above, strongly suggests that questions and propositions are distinct types of semantic objects.

We use embedding under attitude verbs as a test for propositions and questions as semantic objects. Here we do not find mixed boolean combinations of questions and propositions. Thus, for example, *wonder* selects for an embedded question and *believe* for an embedded proposition but a mixed conjunction does not work with either, showing that it is neither a question nor a proposition:

(7) The manager *wonders/*believes that several people left and what rooms we need to clean.

The verb *know* is compatible with both interrogative and declarative complements, though(Vendler, 1972; Ginzburg and Sag, 2000) argue that such predicates do not take questions or propositions as genuine arguments (i.e. not purely referentially), but involve *coercions* which leads to a predication of a *fact*. The well formedness of these coercion processes require that sentences involving decl/int conjunctions such as (8) can only be understood where the verb is distributed over the two conjuncts: "knows that John's smart and knows what qualifications he has":

(8) The manager knows that John's smart and what qualifications he has.

Compare (9a,b)—in the second mixed case there is only a reading which entails that it is surprising the conference was held at the usual time whereas arguably in the first sentence only the conjunction but not the individual conjuncts need be surprising.

(9) a. It's surprising that the conference was held at the usual time and so few people registered.

b. It's surprising that the conference was held at the usual time and how few people registered.

Embedded conditional questions are impossible although, of course, embedded questions containing conditionals are fine:

(10) *The manager wonders if Hollande left, whether we need to clean the west wing.

a. The manager wonders whether, if Hollande left, we need to clean the west wing.

Why, then, do apparent mixed boolean combinations appear in root sentences? Our answer is that natural language connectives, in addition to their function as logical connectives combining propositions, can be used to combine speech acts into another single speech act. This, however, can only be expressed in root sentences and speech acts are not closed under operations corresponding to boolean connectives. For example in (11a), where a query follows an assertion is fine whereas the combination of an assertion with a preceding query is not, as in (11b):

(11) a. John's very smart but does he have any qualifications?

b. *Does John have any qualifications and/but he's smart

This is puzzling because a discourse corresponding to a string of the same separate speech acts works well:

(12) Does John have any qualifications? (no answer) But he's smart.

Similarly, while we can apparently conditionalize a query with a proposition, we cannot conditionalize an assertion with a question, nor can we conditionalize a query with a question:

(13) a. If Hollande left, do we need to clean the west wing? ( "If Hollande left, I ask you whether we need to clean the west wing"),

b. *If whether Hollande left/did Hollande leave, we need to clean the west wing?

c. *If who left, do we need to clean the west wing?

However we treat these facts, it seems clear that it would be dangerous to collapse questions and propositions into the same type of semantic object and allow general application of semantic boolean operators. This would seem to force you into a situation where you have to predict acceptability of these sentences purely on the basis of a theory of syntax, although semantically/pragmatically they would have made perfect sense. It seems to us that distinguishing between questions and propositions and combinations of speech acts offers a more explanatory approach.

## 3 Austinian Types for Propositions and Questions

### 3.1 TTR as synthesizing Constructive Type Theory and Situation Semantics

The system we sketch is formulated in TTR (Cooper, 2012). TTR is a framework that draws its inspirations from two quite distinct sources. One source is Constructive Type Theory, whence the repertory of type constructors, and in particular records and record types, and the notion of witnessing conditions. The second source is situation semantics (Barwise and Perry, 1983; Barwise, 1989) which TTR follows in viewing *semantics as ontology construction*. This is what underlies the emphasis on specifying structures in a model theoretic way, introducing structured objects for explicating properties, propositions, questions etc. It also takes from situation semantics an emphasis on *partiality* as a key feature of information processing. This aspect is exemplified in a key assumption of TTR—the witnessing relation between records and record types: the basic relationship between the two is that a record $r$ is of type $RT$ if each value in $r$ assigned to a given label $l_i$ satisfies the typing constraints imposed by RT on $l_i$:

(14) record witnessing

The record:

$$\begin{bmatrix} l_1 & = & a_1 \\ l_2 & = & a_2 \\ \ldots & & \\ l_n & = & a_n \end{bmatrix}$$ is of type:

$$\begin{bmatrix} l_1 & : & T_1 \\ l_2 & : & T_2(l_1) \\ \ldots & & \\ l_n & : & T_n(l_1, l_2, \ldots, l_{n-1}) \end{bmatrix}$$

iff $a_1 : T_1, a_2 : T_2(a_1), \ldots, a_n : T_n(a_1, a_2, \ldots, a_{n-1})$

This allows for cases where there are fields in the record with labels not mentioned in the record type. This is important when e.g., records are used to model contexts and record types model rules about context change—we do not want to have to predict in advance all information that could be in a context when writing such rules. (15) illustrates this: the record (15a) is of the type (15b), though the former has also a field for FACTS; (15b) constitutes the preconditions for a greeting, where FACTS—the contextual presuppositions—has no role to play.

(15) a. $\begin{bmatrix} \text{spkr} & = & \text{A} \\ \text{addr} & = & \text{B} \\ \text{utt-time} & = & \text{t1} \\ \text{c1} & = & \text{p1} \\ \text{Moves} & = & \langle\rangle \\ \text{qud} & = & \{\} \\ \text{facts} & = & \text{cg1} \end{bmatrix}$

b. $\begin{bmatrix} \text{spkr : IND} \\ \text{addr : IND} \\ \text{utt-time : TIME} \\ \text{c1 : addressing(spkr,addr,utt-time)} \\ \text{Moves} = \langle\rangle\text{: list(LocProp)} \\ \text{qud} = \{\}\text{: set(Question)} \end{bmatrix}$

### 3.2 Propositions

Our starting point is the situation semantics notion of an Austinian proposition (Barwise and Etchemendy, 1987). (Ginzburg, 2012) introduces Austinian propositions as records of the form:

(16) $\begin{bmatrix} \text{sit} & = & s \\ \text{sit-type} & = & T \end{bmatrix}$

This gives us a type theoretic object corresponding to a judgement. The type of Austinian propositions is the record type (17a),where the type *RecType*$^\dagger$ is a basic type which denotes the type of (*non-dependent*) record types closed under meet, join and negation.[1] Truth conditions for Austinian propositions are defined in (17b):

(17) a. *AustProp* $=_{def}$ $\begin{bmatrix} \text{sit} & : & \textit{Rec} \\ \text{sit-type} & : & \textit{RecType}^\dagger \end{bmatrix}$

b. A proposition $p = \begin{bmatrix} \text{sit} & = & s_0 \\ \text{sit-type} & = & ST_0 \end{bmatrix}$ is true iff $s_0 : ST_0$

We introduce negative types by the clause in (18a). Motivated in part by data concerning negative perception complements ((Barwise and Perry, 1983; Cooper, 1998), we can characterize witnesses for negative types by (18b).

(18) a. If $T$ is a type then $\neg T$ is a type

b. $a : \neg T$ iff there is some $T'$ such that $a : T'$ and $T'$ precludes $T$. We assume the existence of a binary, irreflexive and symmetric relation of *preclusion* which satisfies also the following specification:
$T'$ *precludes* $T$ iff either (i) $T = \neg T'$ or, (ii) $T, T'$ are non-negative and there is no $a$ such that $a : T$ and $a : T'$ for any models assigning witnesses to basic types and p(red)types

(19a) and (19b) follow from these two definitions:

(19) a. $a : \neg\neg T$ iff $a : T$

b. $a : T \vee \neg T$ is *not* necessary ($a$ may not be of type $T$ and there may not be any type which precludes $T$ either).

Thus this negation is a hybrid of classical and intuitionistic negation in that (19a) normally holds for classical negation but not intuitionistic whereas (19b), that is failure of the law of the excluded middle, normally holds for intuitionistic negation but not classical negation.

The type of negative (positive) Austinian propositions can be defined as (20a,b), respctively:

(20) a. $\begin{bmatrix} \text{sit} & : & \textit{Rec} \\ \text{sit-type} & : & \textit{RecType}^{\neg\dagger} \end{bmatrix}$

b. $\begin{bmatrix} \text{sit} & : & \textit{Rec} \\ \text{sit-type} & : & \textit{RecType} \end{bmatrix}$

[1]When we say 'the type of record types', this should be understood in a relative, not absolute way. That is, this means the type of record types up to some level of stratification, otherwise foundational problems such as russellian paradoxes can potentially ensue. See (Cooper, 2012) for discussion and a more careful development.

If $p$:*Prop* and $p$.sit-type is $T_1 \wedge T_2$ ($T_1 \vee T_2$) we say that $p$ is the conjunction (disjunction) of $\begin{bmatrix} \text{sit} & = & p.\text{sit} \\ \text{sit-type} & = & T_1 \end{bmatrix}$ and $\begin{bmatrix} \text{sit} & = & p.\text{sit} \\ \text{sit-type} & = & T_2 \end{bmatrix}$.

### 3.3 Questions

Extensive motivation for the view of questions as propositional abstracts has been provided in (Ginzburg, 1995; Ginzburg and Sag, 2000)—TTR contributes to this by providing an improved notion of simultaneous, restricted abstraction: A (basic, non-compound) question is a function from records into propositions. In particular, a polar question is a 0-ary propositional abstract, which in TTR makes it a constant function from the universe of all records into propositions. We propose a refinement of this view which we believe maintains the essential insights of the propositional function approach, motivated in part by the need to enable conjunction and disjunction to be defined for questions.

We introduce a notion of *Austinian questions* defined as records containing a record and a function into record types, the latter associated with the label 'abstr(act)'. The role of *wh*-words on this view is to specify the domains of these functions; in the case of polar questions there is no restriction, hence the function component of such a question is a constant function. (21) exemplifies this for a unary 'who' question and a polar question:

(21) a. $\textit{Who} = \begin{bmatrix} \text{x}_1 : \textit{Ind} \\ \text{c1} : \text{person}(\text{x}_1) \end{bmatrix}$; $\textit{Whether} = \textit{Rec}$;

b. 'Who runs' $\mapsto$ $\begin{bmatrix} \text{sit} = r_1 \\ \text{abstr} = \lambda r{:}\textit{Who}(\begin{bmatrix}\text{c} : \text{run}(r.x_1)\end{bmatrix}) \end{bmatrix}$;

c. 'Whether Bo runs' $\mapsto$ $\begin{bmatrix} \text{sit} = r_1 \\ \text{abstr} = \lambda r{:}\textit{Whether}(\begin{bmatrix}\text{c} : \text{run(b)}\end{bmatrix}) \end{bmatrix}$

We characterize the type AustQuestion within TTR by means of the parametric type given in (22); the parametric component of the type characterizes the range of abstracts that build up questions:

(22) $\textit{AustQuestion}(\text{T}) =_{def} \begin{bmatrix} \text{sit} & : & \textit{Rec} \\ \text{abstr} & : & (T \rightarrow \textit{RecType}) \end{bmatrix}$

Given this, we define the following relation between a situation and a function, which is the basis for defining key coherence answerhood notions such as resolvedness and aboutness (weak partial answerhood (Ginzburg and Sag, 2000)) and question dependence (cf. erotetic implication,(Wiśniewski, 2001)):

(23) $s$ *resolves* $q$, where $q$ is $\lambda r : (T_1)T_2$, (in symbols $s?q$) iff **either**
(i) for some $a : T_1$ $s : q(a)$,
**or**
(ii) $a : T_1$ implies $s : \neg q(a)$

Austinian questions can be conjoined and disjoined though not negated. The definition for conj/disj-unction, from which it follows that $q_1$ and (or) $q_2$ is resolved iff $q_1$ is resolved and (or) $q_2$ is resolved, is as follows:

(24) $$\begin{bmatrix} \text{sit} & = & s \\ \text{abstr} & = & \lambda r : T_1\ (T_2) \end{bmatrix} \wedge \quad (\vee) \begin{bmatrix} \text{sit} & = & s \\ \text{abstr} & = & \lambda r : T_3\ (T_4) \end{bmatrix} = \begin{bmatrix} \text{sit = s} \\ \text{abstr} = \lambda r{:}\begin{bmatrix}\text{left:}T_1 \\ \text{right:}T_3\end{bmatrix} \\ (q_1(r.\text{left}) \wedge (\vee) q_2(r.\text{right})) \end{bmatrix}$$

Following (Cooper and Ginzburg, 2012)) we argue that "negative questions" involve questions relating to negative propositions rather than negations of positive questions. As Cooper and Ginzburg show, such negative questions are crucially distinct from the corresponding positive question. Since we have a clear way of distinguishing negative and positive propositions, we do not conflate positive and negative polar questions.

## 4 Connectives in dialogue

We assume a gameboard dialogue semantics (Ginzburg, 2012) which keeps track of questions under discussion (QUD). One of the central conversational rules in KoS is QSPEC, a conversational rule that licenses either speaker to follow up $q$, the maximal element in QUD with assertions and queries whose QUD update Depends on

$q$. These in turn become MaxQUD. Consequently, QSPEC seems to be able to handle the commonest case of successive questions, as in (25).

(25)

a. Ann: Anyway, talking of over the road, where is she? Is she home?
Betty: No. She's in the Cottage.

b. Arthur: How old is she? Forty?
Evelyn: Forty one!

Nonetheless, not all cases of successive questions do involve a second question which is a subquestion of the first, as exemplified in (26):

(26) On the substantive front, we now have preliminary answers to two key questions: What did the agency do wrong? And who ordered it to target conservative groups? Notwithstanding Miller's resignation, which the President himself announced on Tuesday evening, the answers appear to be: not nearly as much as recent headlines suggest; and, nobody in the Obama Administration. (The New Yorker, May 16, 2013)

In contrast to cases covered by QSPEC, these cases are strange if the second question is posed by the addressee of the first question—one gets the feeling that the original question was ignored:

(27) A: What did the agency do wrong? B: Who ordered it to target conservative groups?

(Ginzburg, 2012) postulates an additional conversational rule that allows a speaker to follow up an initial question with a non-influencing question, where the initial question remains QUD-maximal. We believes this basic treatment allows one to explain how the mixed cases involving conjunctions of assertions and queries can be captured. *and*,*but* and *or* can be used as *discourse particles* which express a relationship between a speech act and the one preceding it:

- *and* can indicate that the following question is Independent of MaxQUD.
- *but* indicates that the following question is not independent, but unexpected given MaxQUD:
  - *John's smart* (no response) *But what qualifications does he have?*
  - *John's smart* might be offered as an enthymematic argument (Breitholtz, 2011; Breitholtz and Cooper, 2011) to a conclusion, e.g. "we should hire John". *but* indicates that the answer to the question might present an enthymematic argument against this conclusion.
- *or* can indicate that $q1$ addresses the same ultimate issue as MaxQUD, so retain both as MaxQUD; sufficient to address one issue since it will resolve both simultaneously:

(28) a. Would you like coffee and biscuits or would you like some fruit or a piece of bread and jam or what do you fancy?

b. are you gonna stay on another day or what are you doing?

c. David Foster Wallace is overrated or which novel by him refutes this view?

## 5 Abstract Entities and Adjectives

How to deal with adjectival modification of propositional and question entities, exemplified in (3,4) above? The extended notion of question required can be explicated within Cooper 2012's theory of semantic frames, inspired by (Fillmore, 1985; Pustejovsky, 1995). Neither Ty2 (Groenendijk and Stokhof, 1997) nor inquisitive semantics in propositional or first order formulation support the development of such an ontology. Cooper formulates a frame as a *record type* (RT). In (29) we exemplify a possible frame for question. Here, the $illoc$ role represents a question's role in discourse, whereas the telic role describes the goal of the process associated with resolving a question — finding a resolving answer. The frame represents a 'default' view of a question, which various in effect non-subsective adjectives can modify (e.g., 'unspoken question' negates the existence of an associated utterance, while 'open question' negates the end point of the resolution event).[2]

[2]Here $Resolve$ maps an austinian proposition and an austinian question to a predicate type. In a more detailed account one would add an additional argument for an information state, given the arguments that this notion is agent–relative (Ginzburg, 1995) and much subsequent literature.

(29) Question $=_{def}$

$$\left[\begin{array}{l} \text{T : Type} \\ \text{external : AustQuestion(T),} \\ \text{illoc : } \left[\begin{array}{l} \text{u : Event} \\ \text{A : Ind} \\ \text{c2 : Ask(A,external,u)} \end{array}\right] \\ \text{telic : } \left[\begin{array}{l} \text{p : AustProp} \\ \text{c1 : Resolve(p,external)} \end{array}\right] \end{array}\right]$$

A type-driven compositional analysis is formulated with adjectives as record type modifiers (functions from RTs to RTs) that pick out frame elements of the appropriate type (for a related view cf. Asher & Luo 2012). For example, *difficult question* has the record type in (30):

(30)

$$\left[\begin{array}{l} \text{T : Type} \\ \text{external : AustQuestion} \\ \text{telic : } \left[\begin{array}{l} \text{p : AustProp} \\ \text{c1 : difficult(Resolve(p,external))} \end{array}\right] \end{array}\right]$$

Records and record types come with a well-known notion of subtyping, often construed syntactically (see e.g., (Betarte and Tasistro, 1998)). However, given our ontological perspective on semantics, we take a semantic perspective on subtyping (see e.g. (Frisch et al., 2008) for a detailed exposition of such an approach.), wherein $T \sqsubset T'$ iff $\{s|s : T\} \subset \{s|s : T'\}$. Given this, a record of the type (29) above can be viewed as also having type:

(31)

$$\left[\begin{array}{l} \text{T : Type} \\ \textit{external} \text{ : AustQuestion(T)} \end{array}\right]$$

This forms the basis of our account of how an adjective such as *difficult* applies simultaneously to *question* and to *path*. *Difficult* is specified as in (32)— a function from record types subsumed by the record type given in the domain whose output involves a modification of the restriction field of the telic role. This yields (32b) when combined with *question* and (32c) when combined with *path*:[3]

(32) a.

$$\text{f : (RT} \sqsubset \left[\begin{array}{l} \text{external : Type} \\ \text{P : Type} \\ \text{telic : } \left[\text{c1 : P}\right] \end{array}\right]\text{)RT[P}\leadsto\text{difficult(P)]}$$

[3]Here $difficult$ maps any type $P$ into the predicate type $difficult(P)$. One probably needs to narrow this specification somewhat.

b.

$$\left[\begin{array}{l} \text{T : Type} \\ \text{external : AustQuestion(T)} \\ \text{telic : } \left[\begin{array}{l} \text{p : AustProp} \\ \text{c1 : difficult(Resolve(p,external))} \end{array}\right] \end{array}\right]$$

c.

$$\left[\begin{array}{l} \text{external : PhysTrajectory} \\ \text{telic : } \left[\begin{array}{l} \text{a : Ind} \\ \text{c1 : difficult(Cross(a,external))} \end{array}\right] \end{array}\right]$$

Turning to propositions, we postulate (33) as a type for proposition. This allows us, for instance, to specify the adjective *silly* as modifying along the *illoc* dimension, thereby capturing *silly claim* (a claim silly to assert) and *silly question* (a question silly to ask); given the specification of the telic dimension and our lexical entry for *difficult*, *difficult claim* is correctly predicted to mean 'a claim difficult to prove'.

(33) Proposition $=_{def}$

$$\left[\begin{array}{l} \text{external : AustProp,} \\ \text{illoc : } \left[\begin{array}{l} \text{u : Event} \\ \text{A : Ind} \\ \text{c2 : Assert(A,external,u)} \end{array}\right] \\ \text{telic : } \left[\begin{array}{l} \text{f : Fact} \\ \text{c1 : Prove(f,external)} \end{array}\right] \end{array}\right]$$

Subject matter adjectives such as *political, personal, moral, philosophical* as in (34) lead us to another intrinsic advantage for rich type theories such as TTR over possible worlds based type theories, relating to the types *AustQuestion/Prop*.

(34) a. A: Are you involved with Demi Lovato?
B: That's a personal question.

b. A: One shouldn't eat meat. B: That's a moral claim.

Subject matter adjectives target the *external* role of a question/proposition. This can be explicated on the basis of the predicate types which constitute the sit-type (abstr type) field in propositions (questions). Given the coarse granularity of possible worlds, it to unclear how to do so in ontologies based on sets of possible worlds.

## Acknowledgments

Earlier versions of portions of this work were presented at the workshop *Conference on Logic,* *Questions and Inquiry (LoQI)* in Paris and at a course on TTR given in June 2013 in Gothenburg. We thanks audiences on those occasions, as well as two anonymous referees for very stimulating comments. This work is supported by the French Investissements d'Avenir–Labex EFL program (ANR-10-LABX-0083).

## References

Jon Barwise and John Etchemendy. 1987. *The Liar*. Oxford University Press, New York.

Jon Barwise and John Perry. 1983. *Situations and Attitudes*. Bradford Books. MIT Press, Cambridge.

Jon Barwise. 1989. *The Situation in Logic*. CSLI Lecture Notes. CSLI Publications, Stanford.

Gustavo Betarte and Alvaro Tasistro. 1998. Martin-löf's type theory with record types and subtyping. In G. Sambin and J. Smith, editors, *25 Years of Constructive Type Theory*. Oxford University Press.

Ellen Breitholtz and Robin Cooper. 2011. Enthymemes as rhetorical resources. In Ron Artstein, Mark Core, David DeVault, Kallirroi Georgila, Elsi Kaiser, and Amanda Stent, editors, *SemDial 2011 (Los Angelogue): Proceedings of the 15th Workshop on the Semantics and Pragmatics of Dialogue*.

Ellen Breitholtz. 2011. Enthymemes under Discussion: Towards a micro-rhetorical approach to dialogue modelling. In *Proceedings of SPR-11 ILCLI International Workshop on Semantics, Pragmatics, and Rhetoric Donostia, 9-11 November 2011*.

R. Cooper and J. Ginzburg. 2012. Negative inquisitiveness and alternatives-based negation. In Maria Aloni, Vadim Kimmelman, Floris Roelofsen, GalitW. Sassoon, Katrin Schulz, and Matthijs Westera, editors, *Logic, Language and Meaning*, volume 7218 of *Lecture Notes in Computer Science*, pages 32–41. Springer Berlin Heidelberg.

Robin Cooper. 1998. Austinian propositions, davidsonian events and perception complements. In Jonathan Ginzburg, Zurab Khasidashvili, Jean Jacques Levy, Carl Vogel, and Enric Vallduvi, editors, *The Tbilisi Symposium on Logic, Language, and Computation: Selected Papers*, Foundations of Logic, Language, and Information, pages 19–34. CSLI Publications, Stanford.

Robin Cooper. 2012. Type theory and semantics in flux. In Ruth Kempson, Nicholas Asher, and Tim Fernando, editors, *Handbook of the Philosophy of Science*, volume 14: Philosophy of Linguistics. Elsevier, Amsterdam.

C.J. Fillmore. 1985. Frames and the semantics of understanding. *Quaderni di semantica*, 6(2):222–254.

Alain Frisch, Giuseppe Castagna, and Véronique Benzaken. 2008. Semantic subtyping: Dealing set-theoretically with function, union, intersection, and negation types. *Journal of the ACM (JACM)*, 55(4):19.

Jonathan Ginzburg and Ivan A. Sag. 2000. *Interrogative Investigations: the form, meaning and use of English Interrogatives*. Number 123 in CSLI Lecture Notes. CSLI Publications, Stanford: California.

Jonathan Ginzburg. 1995. Resolving questions, i. *Linguistics and Philosophy*, 18:459–527.

Jonathan Ginzburg. 2012. *The Interactive Stance: Meaning for Conversation*. Oxford University Press, Oxford.

J. Groenendijk and F. Roelofsen. 2009. Inquisitive semantics and pragmatics. In *Meaning, Content, and Argument: Proceedings of the ILCLI International Workshop on Semantics, Pragmatics, and Rhetoric. www. illc. uva. nl/inquisitive-semantics*.

Jeroen Groenendijk and Martin Stokhof. 1997. Questions. In Johan van Benthem and Alice ter Meulen, editors, *Handbook of Logic and Linguistics*. North Holland, Amsterdam.

C. L. Hamblin. 1958. Questions. *Australian Journal of Philosophy*, 36:159–168.

Lauri Karttunen. 1977. Syntax and semantics of questions. *Linguistics and Philosophy*, 1:3–44.

Rani Nelken and Nissim Francez. 2002. Bilattices and the semantics of natural language questions. *Linguistics and Philosophy*, 25:37–64.

Rani Nelken and Chung-Chieh Shan. 2006. A modal interpretation of the logic of interrogation. *Journal of Logic, Language, and Information*, 15:251–271.

James Pustejovsky. 1995. *The Generative Lexicon*. MIT Press, Cambridge.

Aarne Ranta. 1994. *Type Theoretical Grammar*. Oxford University Press, Oxford.

Zeno Vendler. 1972. *Res Cogitans*. Cornell University Press, Ithaca.

Andrzej Wiśniewski. 2001. Questions and inferences. *Logique et Analyse*, 173:5–43.