Negative inquisitiveness and alternatives-based negation

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Abstract. We propose some fundamental requirements for the treatment of negative particles, positive/negative polar questions, and negative propositions, as they occur in dialogue with questions. We offer a view of negation that combines aspects of alternative semantics, intuitionist negation, and situation semantics. We formalize the account in TTR (a version of type theory with records) [7, 9]. Central to our claim is that negative and positive propositions should be distinguished and that in order to do this they should be defined in terms of types rather than possible worlds. This is in contrast to [11] where negative propositions are identified in terms of the syntactic or morphological properties of the sentences which introduce them.
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1 Introduction

In the classical formal semantics treatments for questions the denotation of a positive polar interrogative (PPInt) p? is identical to that of the corresponding negative polar (NPInt) $\neg p$? [17, 16, for example]. This is because the two interrogatives have identical exhaustive answerhood conditions. Indeed Groenendijk and Stokhof (1997), p. 1089 argue that this identification is fundamental. Recent work within Inquisitive Semantics [15, for example] seems to be equivocal about whether this identity should be preserved.[3]

However, other evidence calls the the identification of PPInt and NPInt denotations into question. (1a,b) based on examples due to [19] seems to describe distinct cognitive states. Hoepelmann, in arguing for this distinction, suggests that (1a) is appropriate for a person recently introduced to the odd/even distinction, whereas (1b) is appropriate in a context where, say, the opaque remarks of a mathematician sow doubt on the previously well-established belief that *two is even.* (1c,d) seem to describe distinct investigations, the first by someone potentially even handed, whereas the second by someone tending towards DSK's innocence.

(1) a. The child wonders whether 2 is even.

[3] Within Inquisitive Semantics p? is equivalent to $\neg p$? for p a propositional variable, but this equivalence is not maintained for ϕ? and $\neg\phi$?, where ϕ is a complex formula. We would like to thank Andrzej Wiśniewski for discussion of this issue.

b. The child wonders whether 2 isn't even.
c. Epstein is investigating whether DSK should be exonerated.
d. Epstein is investigating whether DSK shouldn't be exonerated.

That root PPInts and NPInts are appropriate in distinct contexts is well recognized in the literature since Hoepelmann and [21]. However, it is not merely the background that differs, it is also the *responses* triggered that are markedly and systematically different. A corpus study of the British National Corpus, whose results are displayed in Table 1, reveals that the two types of interrogatives exhibit almost a mirror image distribution:[4] it suggests that PPInts p? are significantly biassed to eliciting p, whereas NPInts $\neg p$? are almost identically biassed to eliciting $\neg p$:

Table 1: Distribution of responses to Positive ('Did..?')/Negative ('Didn't..?') polar interrogatives in the British National Corpus

Question type	Positive answer	Negative answer	No answer	Total
`Positive polar`	53%	31%	16%	n = 106
`Negative polar`	23%	54%	22%	n = 86

[14], who developed a view of questions as propositional abstracts, showed how such an account, combined with a theory of negative situation types developed in [6], can distinguish between PPInts and NPInts denotations and presuppositions while capturing the identity of resolving answerhood conditions. Their account relied on a complex *ad hoc* notion of simultaneous abstraction. In this paper we consider a number of phenomena relating negation and dialogue, on the basis of which we develop an account of propositional negation in the framework of Type Theory with Records (TTR) [8, 9]. This account extends the earlier results in a type theoretic framework, based on standard notions of negation and abstraction. An important part of the analysis is that we distinguish semantically between positive and negative propositions. This is possible because our type theory is intensional and we have a more fine-grained notion of proposition developed from the conception of propositions as types than, for example, the notion of proposition in inquisitive semantics which is developed from the conception of propositions as sets of possible worlds. Part of our argument for making the distinction between positive and negative propositions is based on data which Farkas and Roelofsen [11] analyze in terms of inquisitive semantics where they rely on syntactic features of utterances in order to distinguish those propositions which are to count as negative.

[4] Our pilot corpus study searched the BNC using SCoRE [27]. For the NPInts the sample reported below consists of all the NPInts of the form 'Didn't ...?' that we found. For the PPInts we found 1500 hits of the form 'Did ...?'. From these we selected a random sample of 106. The 'no answer' category includes cases where either no response concerning the question was forthcoming or where it was difficult to understand how the information provided resolved the question.

2 Negation in simple dialogue

(2) a. [child B approaches socket with nail]
A:(1) No. (2) Do you want to be electrocuted?
(2') Don't you want to be electrocuted?
B: (3) No.
A: (4) No.

b. A: (1) Did Merkel threaten Papandreou?
B:(2) No.
A: (3) That can't be true.
C(4): No.

c. A: Marie est une bonne étudiante? B: Oui / #Si.
A: Marie n'est pas une bonne étudiante? B: #Oui / Si.

From (2a,b,c) one can extract some fundamental requirements for a theory of negation in dialogue. In (2a(1)) B's initial action provides the background for A's initial utterance of 'No', in which A ultimately expresses a wish for the negative situation type ¬StickIn(B,nail,socket). More generally, we argue that this type of use ('Neg(ative)Vol(itional) 'No') involves the specification of a negative situation/event type, thereby providing motivation for (3a). Additional motivation for this is provided by complements of naked infinitive clauses discussed below and the large body of work on the processing of negation, reviewed recently in [20]. Kaup offers experimental evidence that comprehending a negative sentence (e.g. *Sam is not wearing a hat*) involves simulating a scene consistent with the negated sentence. She suggests that indeed initially subjects simulate an "unnegated" scene (e.g. involving Sam wearing a hat). [30] offer additional evidence supporting the simulationist perspective. However, they argue against the "two step" view of negation (viz. unnegated and then negated), in favour of a view driven by dialogical coherence, based on QUD.

In the aftermath of (2a(1)), (2a(2)) would be a reasonable question to ask, whereas (2a(2')) would be grounds for summoning the social services. This, together with our earlier discussion on PPInts and NPInts motivates (3b). Assuming (2a(2)) were uttered, B's response asserts the negation of the proposition $p_{\mathrm{Want(B,electr(B))}}$. A can now *agree* with B by uttering 'No'. That is, 'propositional' No always resolves to a negative proposition. This partly motivates (3c). Additional motivation for this is the existence in many languages, such as French and Georgian, of dialogue particles which presuppose respectively a positive (negative) polar question as the maximal element in QUD (MaxQUD), as in (2c).

In (2b(2)) B retorts with $\neg p_1$ (p_1 = **Threaten(Merkel,Papandreou)**), whereas in (2b(3)) A disagrees with B and affirms $\neg\neg p_1$. Clearly, we need (2b(3)) to imply p_1, but this should not be *identified* with p_1—C's utterance (2b(4)) can be understood as agreement with A, not with B, hence motivating (3d).

(3) **Informal intuitive desiderata for a theory of positive and negative situation types and propositions**

a. **Negative situation types evoke precluding positive types**: If a situation s is of a negative type $\neg T$, then s is of some positive type T'

which precludes T, that is no situation can be both of type T and T'

b. **Positive/negative polar question distinction**: If p is a proposition and p? is the question whether p then p? should query whether p is true; The question derived from the corresponding negative proposition $\neg p$, $\neg p$?, should query whether $\neg p$ is true; these questions are distinct though have equivalent resolving answerhood conditions.

c. **Negative propositions**: negative propositions are recognizably distinct from positive propositions.

d. **Equivalence but non-identity of p and $\neg\neg p$**: The propositions p and $\neg\neg p$ should be distinct but nevertheless truthconditionally equivalent.

In the following we will attempt to characterize a system which meets these informal criteria and makes the notions involved more precise.

3 Negation and types

Our discussion builds on what Luo [22, 23] calls "modern" type theory and what we will call *rich* type theory, since it presents a much larger selection of types than the simple type theory used, for example, by Montague [25]. Central to type theory (see, e.g. [24, 26]) is the notion of a judgement that objects are of certain types. The judgement that a is of type T is written in symbols as $a : T$. We will also express this by saying that a is a *witness* for T. Ranta [28] suggested that non-mathematical declarative sentences in natural language correspond to types of Davidsonian events. This idea has been taken up and elaborated in [7] and elsewhere where the term *situation* (relating intuitively back to work in situation semantics [2]). The discussion here builds on the type theoretical dictum: "propositions as types". The idea is that we can consider propositions to be types of situations (possibly among other things). If a type has at least one witness it corresponds to a true proposition. A type with no witnesses corresponds to a false proposition. When considering types as propositions Martin-Löf [24] also referred to witnesses for types as *proofs* or *proof objects*.

In [10] we considered various options for treating negation in TTR considering negation as complement in possible worlds, intuitionistic negation, classical negation as a variant of intuitionistic negation, infonic negation, and negation in simulation semantics.

In our version of *intuitionistic negation* the negation of type T is viewed as the type of functions $(T \to \bot)$ where $\bot$ is a necessarily empty type. In terms of TTR we say that $\{a \mid a : \bot\} = \emptyset$ no matter what is assigned to the basic types, thus giving $\bot$ a modal character: it is not only empty but *necessarily* empty. If T is a type then $\neg T$ is the function type $(T \to \bot)$. This works as follows: if T is a type corresponding to a proposition it is "true" just in case there is something of type T (i.e. a witness or proof) and "false" just in case there is nothing of type T. Now suppose there is a function of type $\neg T$. If there is something a of type T then a function f of type $\neg T$ would have to be such that $f(a) : \bot$. But $\bot$, as we know, is empty. Therefore there cannot be any function of type $\neg T$. The only way there can be a function of type $\neg T$ is if T itself is empty. Then there can be a function which returns an object of type $\bot$ for any object of type T, since, T being empty, it will never be required to return anything.

This gives us a notion of negative type, that is a function type whose range type is $\bot$, which can be made distinct from positive types (which could be anything other than a negative type, though in practice we use record types as the basis for our propositions). In this way we fulfil (3c) by making negative types distinct from non-negative types. However, the proposals made in [10] did not yet give us a *type* of negative propositions. The problem is that for any type T there are infinitely many corresponding negative types $(T \to \bot)$, $((T \to \bot) \to \bot)$ and so on. All of these are types and therefore, if we allow a type *Type* of types[5] they will all be of type *Type*. Things become a little more complicated when we want to talk of some particular collection of types closed under negation as we do below. If $\mathcal{T}$ is a type of types then we shall use $cl_\neg(\mathcal{T})$ to represent the type of types whose witnesses are the closure of the set of witnesses of $\mathcal{T}$ under $\neg$. We shall also use $map_\neg(\mathcal{T})$ to represent the type $\mathfrak{T}$ such that $\neg T : \mathfrak{T}$ iff $T : \mathcal{T}$. This gets us a type whose witnesses involve one iteration of negation over the types belonging to $\mathcal{T}$, leaving out the types we started with, that is, a type of negative types.

Given this, and following [13], we introduce situation semantics style Austinian propositions into TTR [7, 9]. These are objects of type (4a). (4a) is a *record type*, that is a set of pairs consisting of a label (represented to the left of the colon) and a type (represented to the right of the colon).[6] An object is of a record type if it is a record containing fields with the same labels as in the record type with objects in those fields which are of the types specified in the record type. An example of an Austinian proposition of this type would be (4b). Here *RecType* is the type of record types as defined in [7, 9] and 'run(sam)' is the type of situation in which 'sam' runs. Denoting (4a) by *AusProp*, the type of Austinian propositions, we can say that *NegAusProp*, the type of negative Austinian propositions, is (4c).

(4) a. $\begin{bmatrix} \text{sit} & : \mathit{Rec} \\ \text{sit-type} & : \mathit{cl}_\neg(\mathit{RecType}) \end{bmatrix}$

b. $\begin{bmatrix} \text{sit} & = s \\ \text{sit-type} & = \begin{bmatrix} \text{c}_{\text{run}}\text{:run(sam)} \end{bmatrix} \end{bmatrix}$

c. $\begin{bmatrix} \text{sit} & : \mathit{Rec} \\ \text{sit-type} & : \mathit{cl}_\neg(\mathit{map}_\neg(\mathit{RecType})) \end{bmatrix}$

Truth for these Austinian propositions involves a notion of Austinian witness which in turn involves a notion of incompatible types. Two types T_1 and T_2 are

[5] We can do this if we are careful to avoid paradoxes, for example by stratifying the types as we do in [7, 9].

[6] The types may be dependent. See [7, 9] for details.

incompatible just in case for any a not both $a : T_1$ and $a : T_2$, no matter what assignments are made to basic types. Incompatibility thus means that there is necessarily no overlap in the set of witnesses for the two types. In order to be fully viable *incompatibility* needs to be further restricted using a notion of *alternativehood* [5]. In some cases what the alternatives amount to is fairly straightforward and even lexicalized—classifying the table as *not black* requires evidence that it is green or brown or blue, say. But in general, figuring out the alternatives, as Cohen illustrates, is of course itself context dependent, relating to QUD (Questions Under Discussion).

Using the notion of "model" defined in [9], that is, an assignment of objects to basic types and to basic situation types constructed from a predicate and appropriate arguments, we can characterize the set of witnesses for a type T with respect to "model" M, $[\check{}T]^M$, to be $\{a \mid a :_M T\}$ where the notation $a :_M T$ means that a is a witness for type T according to assignment M. We can then say that two types T_1 and T_2 are *incompatible* if and only if for all M, $[\check{}T_1]^M \cap [\check{}T_2]^M = \emptyset$.

We define a notion of *Austinian witness* for record types closed under negation:

(5) a. If T is a record type, then s is an Austinian witness for T iff $s : T$
b. If T is a record type, then s is an Austinian witness for $\neg T$ iff $s : T'$ for some T' incompatible with T
c. If T is a type $\neg\neg T'$ then s is an Austinian witness for T iff s is an Austinian witness for T'

The intuitions behind clauses (5b) and (5c) are based on the intuitive account of intuitionistic negation. (5b) is based on the fact that a way to show that s being of type T would lead to a contradiction is to show that s belongs to a type that is incompatible with T. (5c) is based on the fact that if you want to show that a function of type $(T \to \bot)$ would lead to a contradiction requires finding a witness for T.

We say that an Austinian proposition p is *true* iff p.sit is an Austinian witness for p.sit-type. Notice that if p is true in this sense then p.sit-type will be non-empty, that is, "true" in the standard type-theoretical sense for propositions as types. If p is an Austinian proposition as in (6a), then the negation of p, $\neg p$, is (6b):

(6) a. $\begin{bmatrix} \text{sit} & = s \\ \text{sit-type} & = T \end{bmatrix}$ b. $\begin{bmatrix} \text{sit} & = s \\ \text{sit-type} & = \neg T \end{bmatrix}$

We obtain the desideratum (3a) in virtue of the requirement involving an incompatible type in (5b). We obtain the desideratum (3c) because negative propositions are distinct from positive propositions. We obtain (3d) because double negations of propositions will be distinct from the original proposition but they will now (contrary to intuitionistic propositions) be truth-conditionally equivalent (that is, an Austinian proposition will be true just in case its double negation is true in virtue of (5c)).

4 Negation and inquisitiveness

In unpublished work Farkas and Roelofsen [11] and Brasoveanu, Farkas and Roelofsen [3] deal with a range of examples related to (2c). In order to treat these examples it is important to distinguish between negative and positive assertions and questions. One initial problem that arises is that questions correspond to sets of sets of possible worlds corresponding to the positive possibility and the negative possibility and thus the positive and negative questions are not distinguished. In order to solve this they make use of highlighting as introduced in [29]. According to this view compositional semantics introduces something more like what we might represent as a record structure, that is, an interpretation which is divided into two components: a highlighted proposal and a set of possibilities. However, there is still a remaining problem of determining which of the highlighted possibilities are negative. As they point out sets of possible worlds do not distinguish between negative and positive propositions. For example, they discuss *John failed the exam* and *John did not pass the exam* as corresponding to the same set of possible worlds. For us these would be two distinct propositions. In order to make the distinction between positive and negative propositions, they use the syntax of the sentences which introduce them. This we see as problematic. As we point out in [10], languages use various ways of expressing negation. In addition to standard negative particles, languages have a variety of ways of expressing negation and we run the risk of listing an arbitrary set of morphemes or constructions if we cannot characterize semantically the fact that they engender negative propositions.

5 Alternatives

It is widely recognized that positive Naked Infinitive (NI) sentences describe an agent's perception of a situation/event, one which satisfies the descriptive conditions provided by the NI clause, as in (7a,b). More tricky is the need to capture the 'constructive' nature of negation in negative NI sentences such as (7c,d). These reports mean that s actually possesses information which rules out the descriptive condition (e.g. for (7c) Mary avoiding contact with Bill), rather than simply lacking concrete evidence for this (e.g. Ralph shutting his eyes.). As [6] points out, Davidsonian accounts (e.g. [18]), are limited to the far weaker (7f):

(7) a. Ralph saw Mary serve Bill. b. Saw(R,s) $\wedge$ s : Serve(m,b).
c. Ralph saw Mary not serve Bill. d. Ralph saw Mary not pay her bill.
e. Saw(R,s) $\wedge$ s : $\neg$ Serve(m,b). f. Saw(R,s) $\wedge$ $s \not{:} Serve(m,b)$

[6] provides axioms on negative SOAs (infons) in situation semantics that attempt to capture this, as in (8a,b). (8a) states that if a situation s supports the dual of σ, then s also supports positive information that precludes σ being the case. (8b) tells us that if a situation s supports the dual of σ, then s also supports information that defeasibly entails that σ is the case.

(8) a. $\forall s, \sigma[s : \overline{\sigma}$ implies
$\exists(Pos)\psi[s : \psi \;\text{ and }\; \psi \Rightarrow \overline{\sigma}]]$
b. $\forall s, \sigma[s : \overline{\sigma}$ implies
$\exists(Pos)\psi[s : \psi \;\text{ and }\; \psi > \sigma]]$

(5) accounts for (8a). In order to cover (8b) we could refine (5) as in (9).

(9) If T is a record type, then s is an Austinian witness for $\neg T$ iff $s : T'$ for some T' incompatible with T and there is some T'' such that $s : T''$ and if any situation is of type T'' this creates the expectation that it is also of type T.

We do not at this point have a precise proposal for treating the notion "creates the expectation". However it is done, it would mean that T' (the type that is incompatible with T) is regarded as an alternative for T given T''. One way of handling these defeasible inferences is in terms of Aristotelian enthymemes as discussed in [4]. We regard these as being resources available to agents either in particular limited types of contexts or as part of their general knowledge. For example, Fillmore's [12] examples (10), uttered out of context, depend on such general knowledge.[7]

(10) a. Her father doesn't have any teeth.
b. # Her husband doesn't have any walnut shells.
c. Your drawing of the teacher has no nose/#noses.
d. The statue's left foot has no #toe/toes.

We generally assume that people have teeth but not walnut shells and that humans have one nose but many toes. Such resources may also be local to a restricted domain or even a single dialogue or even part of a dialogue. So, for example, a previous turn in a dialogue is sufficient to create an association between husbands and walnut shells, thus making (10b) acceptable.

(11) A: My husband keeps walnut shells in the bedroom.
B: Millie's lucky in that respect. Her husband doesn't have any walnut shells.

This particular resource is quite likely not going to be used beyond this particular dialogue.

6 Polar Interrogatives

We are left with the desideratum (3b). We follow [14] in analyzing polar questions as 0-ary propositional abstracts. We rely on a standard type theoretic notion of abstraction, couched in terms of functional types. For instance, (2a(2)) and (2a(2')) would be assigned the 0-ary abstracts in (12a) and (12b) respectively.

[7] (i) from the BNC illustrates an actual context for (10a):
(i)Marjorie: You just get in, have your tea, and Alexandro'll come round, come for a beer. Clive: There's Tony, look. He ain't got no teeth now, look. (BNC, KC2)

These are *distinct* functions from records of type [] (in other words from all records) into the corresponding Austinian propositions, which do not depend on the particular record chosen as an argument (that is, r does not occur in the notation for the resulting type). This use of vacuous abstraction corresponds to the proposal in [14] to treat polar questions as vacuous abstracts and *wh*-questions as non-vacuous abstracts. This accords with the need to distinguish the distribution of their expected responses and the information states of questioners asking or agents investigating the corresponding issues:

(12) a. $\lambda r{:}Rec\ (\begin{bmatrix} \text{sit} = \text{s} \\ \text{sit-type} = \begin{bmatrix} \text{c} : \text{want(B(electrocute(B)))} \end{bmatrix} \end{bmatrix})$

b. $\lambda r{:}Rec\ (\begin{bmatrix} \text{sit} = \text{s} \\ \text{sit-type} = \begin{bmatrix} \text{c} : \neg\text{want(B(electrocute(B)))} \end{bmatrix} \end{bmatrix})$

As we mentioned in section 5, the witnessing conditions associated with negative situation types could be strengthened as in (9) so that witnessing $\neg T$ involves the existence of T'' such that $s : T''$ and $T'' > T$. Hence, wondering about $\lambda r{:}Rec\ (\begin{bmatrix} \text{sit} = \text{s} \\ \text{sit-type} = \neg\text{T} \end{bmatrix})$ involves wondering about whether s has the characteristics that typically involve T being the case, but which—nonetheless, in this case—fail to bring about T. The *simple answerhood* relation of [14] recast in TTR will ensure that the exhaustive answer to p? are $\{p, \neg p\}$, whereas to $\neg p$? they are $\{\neg p, \neg\neg p\}$, so the exhaustive answers are equivalent, as needed.

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