Incrementing Discourse with the Negation Relation

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1 Negation as a relation

Logical translations of English sentences typically translate sentential negation as a unary propositional operator. In this paper, I develop the processing aspect of a rather different ontological perspective on negation: namely, negation as a two-place relation. The negation relation takes one argument, its associate, and relates it to the rest of the sentence which forms the second argument, its frame. The truth conditions of the relation are equivalent to those of the wide-scope unary operator. However, sentences with the same truth conditions may be logically distinct due to their distinct arguments to the relation. For example, (1) and (2) have identical truth conditions, but the distinct logical structures shown.

(1) Ann didn't give THE INK to Bea
    $[_R \not\in] [_A$ the ink$] [_F \lambda x(\text{Ann gave } x \text{ to Bea})]$
(2) Ann didn't give the ink to BEA
    $[_R \not\in] [_A$ Bea$] [_F \lambda x(\text{Ann gave the ink } x)]$

For the purposes here, sentential negation is a negative element in auxiliary verb position, either the negative inflection *n't* or the free *not* in that position. Sentences with other negative forms are not under consideration, even though they may meet other definitions for sentential negation, e.g. those proposed by Klima (1964) and Jackendoff (1969).

The associate to negation may be distinguished from both stress-focus, a constituent which is marked by relative phonetic prominence, and information-focus, a constituent which conveys new information or makes the point of the utterance. Most commonly, information-focus and associates are marked by the use of stress-focus. However, all three of these things are often called "focus," suggesting an incorrect identification. The distinction is necessary because it is not the case that information-focus or associates are always marked by stress-focus.

Briefly, I compare the negation relation with two related proposals, that of Horn (1989) and the Prague school (Hajičová 1984, Sgall et al. 1986). Horn argues that the Aristotelian system of predicate term logic, which analyzes negation as a mode of predication, is a more accurate formulation of linguistic negation. According to this mode analysis, sentential negation expresses that the predicate does not hold of the subject for any reason, including, e.g., reference failures. As a result, the mode analysis is identical in truth conditions to the unary propositional operator with wide scope. However, it is distinct in structure. The mode analysis of negation involves a linking of two elements, subject and predicate, to form a distinct kind of element, a sentence or proposition. This contrasts with unary negation which takes one element, its scope which is a proposition, and forms the same kind of element. In effect, the mode analysis claims that the scope of negation is structured as subject and predicate and that negation is a way to link these two pieces.

In propositional logic, the unary operator is an external connective, in the same category with *and* and *or*. Truth functionally, it takes a single formula as an argument and inverts its truth value. In this logic, then, the affirmative is more basic than the negative because the negative takes the affirmative as an argument. The affirmative may be formulated independently of the negative but not vice versa. Also, the unary negation may apply to the entire sentence to a subformula. Under the mode analysis, negation is not derivative on affirmation. Rather, the two form a category, the possible ways of linking subject and predicate. Also, the mode negation has a fixed scope. As support for the mode analysis over the unary analysis, Horn points out that negation does not iterate freely and that languages never have negation in the external syntactic position which would suggest the unary operator.

The relation analysis I am advocating is a generalization of the mode analysis. The negation relation links two pieces to form a sentence, but these two pieces are not constrained to be the subject and predicate. Without a stress-focus, negation relates subject and predicate. If there is a stress-focus, negation relates the

stress-focus to the rest of the sentence. The same arguments which support the mode analysis over the unary analysis also hold for the relation analysis. The negation relation may select any constituent as its associate, a selection which also determines the frame. However, the truth conditions remain equivalent to those of a wide-scope unary operator; they do not vary with the different argument pairs. The negation relation introduces a logical structure of two arguments. All the ways of selecting the arguments from a sentence will result in equivalent truth conditions. If we continue to use the term "scope" to mean the argument of the unary operator, the negation relation imposes a logical structure on the scope of the unary negation.

Work in the Prague school on negation (Hajičová 1984, Sgall et al. 1986), explores the interaction between negation and the information structure. The framework developed by these authors centers around the relationship of each utterance to the ongoing discourse. Communicative dynamism, a concept developed by Firbas, is a gradient property of a linguistic element, its ability to move the communication forward. For this aspect of interpretation, the representation of the sentence is linearized so that all the elements of the sentence are arranged in a systematic ordering according to their communicative dynamism. With respect to this ranking of the elements of the sentence, a topic-focus articulation is defined which divides the sentence into a portion which is contextually bound and non-bound. Thus, while communicative dynamism is gradient, there is a boundary in this ordering. To the left of the boundary are the contextually bound elements of the topic and to the right of the boundary are the non-bound elements of the focus. The boundary has the same significance as the distinction between ground (= Praguean topic) and information-focus (= Praguean focus) discussed in §3. This boundary is crucial to determining the scope of negation.

Stated broadly, the central Praguean claim about negation is one which I am defending: "... it is primarily the relationship between [ground] and [information-]focus that is negated: In the unmarked case, a negative sentence states that its [information-]focus does not hold about its [ground]." (Sgall et al. 1986:83). However, this work claims that the boundary between ground and information-focus defines the scope of negation rather than an argument structure. The content in the ground falls outside the scope of negation and so will be logically entailed. Wide scope negation is, for these authors, only possible when a sentence lacks a ground. Contrary to this claim, negation can have wider scope than something in ground. In (3), *every dog* is clearly contextually bound, yet it is inside the scope of the negation.

(3) *Who walked every dog?*
    Ricki didn't walk every dog

(4) *Who didn't Ricki give A BONE to?*
    Ricki didn't give a bone to HER DOG

One difference between the relation analysis and the others mentioned is that negation can have an associate which is independent of stress-focus or information-focus. For example, in (4), negation has the direct object as its associate, while the indirect object is the information-focus and a stress-focus. The negation relation in this example is embedded in another relation-associate-frame structure. These examples will not be of concern here.

2   Semantic analysis

Besides negation and affirmation, focus particles such as *only* and *even* express relations between an associate and frame. Here I summarize the unified semantic analysis of these particles given by Moser (1992b). To begin with, consider *only* and its interaction with stress-focus. A variation in stress-focus in an *only* sentence can lead to different truth conditions. Note the different truth conditions for (5) and (6). Since there is no discernible difference between a stress-focus in an *only* sentence and one in another context, this systematic effect of stress-focus on truth-conditions supports the inclusion of stress-focus as part of the formal structure of any sentence, as argued for by Klein (1991) and as will be assumed here. Stress-focus is effectively a structural feature along with the position features, the more traditional structural features relating to placement in a syntax tree. There is a formal difference between two sentences which have exactly the same sequence of words based on how they are stressed, a difference which is realized by a particular prosodic feature, that of stress. Thus, (5) and (6) are not the same sentence with different intonation, rather, they are formally different sentences.

In addition to a stress-focus associate, *only* may occur without a stress-focus as in (7). In these cases, its associate is the adjacent constituent. The relation analysis applies independently of how *only*'s associate is determined, through position or stress. The same observations hold true for the associate of negation, but without the truth conditional consequences noted for (5) and (6).

(5) Ann only gave THE INK to Bea
    $[_R$ unique-$\in]$ $[_A$ ink$]$ $[_F$ $\lambda x($Ann gave x to Bea$)]$

(6) Ann only gave the ink to BEA
    $[_R$ unique-$\in]$ $[_A$ Bea$]$ $[_F$ $\lambda x($Ann gave ink to $x)]$

(7) Ann gave only the ink to BEA

A relation and its associate, regardless of whether determined by position or stress, may be viewed as structuring the logical proposition. That is, the relation-associate-frame structure is a formal object, an instance of the structured meanings discussed by Cresswell (1985) and von Stechow (1988). The interpretation of these relation-associate-frame structures is a three step process. First, a set of alternatives to the associate is determined. These alternatives are things which are similar to the associate in contextually relevant ways. To determine the alternatives, the relevant syntactic-semantic type is inferred from the associate. Then, starting from the instances of this type, there may be further contextual restrictions on the members of the alternatives. For (5), the syntactic-semantic type might be art supplies. Then, the context could be restrictive so that only the ink and paint are in the set of alternatives. The second step in the interpretation is that the frame is used to select a subset of these alternatives, call it the frame set. In this case, the frame set will be the subset of the alternative supplies which Ann gave Bea. Third, the *only* relation must hold between the associate and the frame set in order for the sentence to be true. For (5) to be true, the frame set, those art supplies which Ann gave to Bea, will have the ink as their unique element.

The two-place relations expressed by focus particles do not have their arguments rigidly typed. Rather, the associate may be of any semantic type and the frame will be a set of elements of that type. Semantically, these particles denote element-to-set relations. Defining them this way allows for an associate that is either a stress-focus or an adjacent constituent. The general definition of focus-particles as element-to-set relations raises the question of how the associate, the element argument to the relation, is determined. The answer I suggest is that the position of the focus particle determines an environment for the associate. Then, the associate will be the closest stress-focus in that environment or it will be the entire environment. Thus, the syntactic relationship between particle and associate, stress and locality all play a role in determining the associate of a focus particle.

3   Information structure

In this section, I note the similarity between the relation-associate-frame structure just discussed and information structure. Conceptually, information structure is the differentiation of the content of a sentence according to the speaker's beliefs about the hearer's knowledge or current awareness. Chafe (1976) describes this in terms of the metaphor of packaging, noting that the same logical content can be packaged in various ways depending on what it is being used for. Information structure is a kind of non-truth-conditional meaning which is inherently pragmatic because it is defined with reference to speaker, hearer and context. However, while the meaning conveyed involves contextual factors, it does not follow that the means of conveying it does. That is, while information structure expresses how a sentence fits in the context, it is possible that context is not a factor in determining the information structure itself. Recent work by Vallduví (1990) suggests that information structure be viewed as one aspect of the formal structure of a sentence, on a par with predicate-argument structure and logical form.

The major constituents of information structure are the information-focus, the portion of content which the speaker deems will be informative or will make the point of the sentence, and the ground, the remainder of the content which is assumed to be uncontroversial and serves as a vehicle for the information-focus. As a subpart, the ground contains the link, the particular entity which the utterance is about. The features which mark the information-focus are the same position and stress features described for determining an associate. In fact, in Moser (1992a), I propose the major constituents of information structure be extended to include a relation between information-focus and ground, making it a tripartite structure. As evidence for this extension, I note the tendency of negation and *only* to accompany the information-focus in constructions which mark information structure by placing the information-focus in an isolated position. Thus, information structure is an instance of a relation-associate-frame structure.

While the structure and formal marking of information structure are identical to the relation structures already discussed, the interpretation is not. The semantic interpretation by generating alternatives, selecting a frame set and checking the relation between associate and frame set expresses nothing about the hearer's awareness. Instead, information structure is an additional interpretation of a relation structure, made simultaneously with the semantic one. Vallduví proposes that the pragmatic interpretation of information structure is effectively instructions to the hearer for updating mental file cards for the entities in the discourse. Here I take a slightly different perspective, i.e. that the instructions are concerned with updating a file card representation which is external to the discourse participants.

The link specifies the address at which the information of the utterance is to be stored, so its pragmatic interpretation is a GO-TO instruction. The ground specifies content which is currently known or under discussion, a command to RETRIEVE an open proposition from a file card. Finally, I modify Vallduví's instructions to allow for a relation constituent as part of information structure. Rather than SUBSTITUTE the information-focus into the ground, the more general

RELATE information-focus to ground using a specific relation is used. Consider the example in (8). Each constituent of information structure is interpreted by an instruction; the link is used to locate a file card, the ground is used find an open proposition which is expected to be there, and the information-focus is used to fill in the open proposition depending on what relation is specified. The result is a single, unstructured proposition on the appropriate file card. If the information structure used to convey this proposition were different, the file card update would be done differently, although the same proposition would result.

(8) The girls published THE BOOK
$[_R \in] [_A$ the book] $[_F [_L$ the girls] published $x]$
(i) GO-TO(the girls)
(ii) RETRIEVE($\_$ published x)
(iii) RELATE($\in$, the book, x)

There are two ways in which these instructions are inadequate. First, the ground may require distinct interpretations depending on the syntactic construction used. Prince (1986) discusses a variety of constructions which mark an open proposition as presupposed. The different constructions vary in the way their open proposition is presupposed, however. Second, this is a literal interpretation of information structure which does not address the more complex possibilities for its interaction with the context.

4 Discourse incrementation

The representation of the ongoing discourse has the structure of a set of file cards. One file card is maintained for each entity under discussion, a catalogue of the predications made about that entity. The discourse content which is being negotiated is the sum of information on all the file cards. File cards are a metaphor for a particular organization of information, one which has been independently suggested by authors concerned with several areas of inquiry in cognitive science. Each file card is arranged with two parts: (i) a marker or index, an element of pure reference distinct from any particular predication about the entity, and (ii) a list of unstructured propositions, either affirmative or negative.

In a file card representation of discourse, there is a natural distinction between the function of NPs, which pick out file cards, and the function of the sentence which NPs are embedded in, which specify predications to go on the file cards. For each NP in an utterance, a file card is activated, i.e. associated with a discourse marker with the predicates contained in the NP. The rules for this activation make use of the NP's form as pronoun, definite or indefinite, and will not be

discussed here. The distinction between the NP function as file card activators and the rest of the *sentence* as adding predications to the file card is a kind of processing distinction. No difference in truth conditions arise from the autonomy of file card activation. However, Prince (1990) suggests some linguistic evidence for this processing distinction. In Moser (1992a), I suggest that this distinction in negative sentences may help account for the tendency of referring expressions to be understood as outside the scope of negation. Negative sentences followed by a denial of existence are argued to be cases of constructing file cards for entities which do not exist.

Once the file cards are activated, the process of their updating takes the structured proposition and enters the appropriate fact(s) (=unstructured proposition) on the activated file cards. In the process of this updating, the pragmatic interpretation of the relation structure as information structure arises and may produce inferences which connect to the preceding discourse. The result of this updating must be at least the appropriate entries on the file cards to reflect the semantics of the sentence. A model theoretic semantics for a file card representation of discourse is defined by Heim (1982) in terms of a function for embedding the set of file cards in a model. Assuming this embedding function, the truth conditions of relation structures are sufficiently specified by entries on the file cards.

Example (9) will be used to illustrate discourse incrementation. Since the activation of file cards takes place independently, the structured proposition for the increment is (10). Assume that the file cards for the context are as shown in Figure 1. First, a set of alternatives to the information-focus is constructed. Recall that this consists of a set of contextually relevant things which match the associate (=information-focus) in semantic type. In this example, the set in (11) will be derived. The update to file cards may require these alternatives. Based on the earlier discussion, the initial formulation of the update is the set of instructions in (12). The GO-TO instruction specifies that the file card to be updated is d_2 and will not be of further concern here.

(9) *WWII Veteran's description of Germans' surrender to his battalion by the Elbe River:*
They swam the river to surrender to us
thousands of them–
They didn't want to surrender to THE RUSSIANS

(10) $[_R \not\in] [_A d_4] [_F \lambda x ([_L d_2]$ want to surr. to $x)]$

(11) {the Russians, the British, the Americans}

(12) (i) GO-TO(d_2)
(ii) RETRIEVE($\_$ want to surrender to x)
(iii) RELATE($\not\in$, d_4, x)

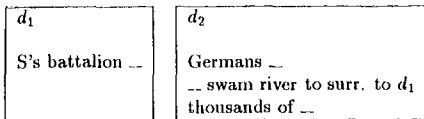| d_1	d_2
S's battalion __	Germans __ __ swam river to surr. to d_1 thousands of __

Figure 1: File cards prior to incrementation with (9)

Speaking generally, the update instructions express a literal information structure interpretation. That is, retrieving the ground from the prior discourse or from the hearer's knowledge store and supplying a value for its variable correspond closely with the question test which is often cited as a diagnostic for information-focus. The ground is that part of the utterance which could have been an immediately preceding question and the information-focus is the answer to that question. For example, (13) could answer the question shown but not (14). Providing the answer to a question is a very literal characterization of being informative. However, the content of the information-focus is perhaps not directly informative and the content of the ground is perhaps not directly known. Instead, in virtue of being presented as information-focus and ground, the function of these two constituents may be achieved indirectly through inferencing. Content which is presented as informative may give rise to inferences which make it informative. Similarly for the ground, inferences may arise which transform unknown content into known content because the information was presented by the speaker as being known. Given the literal interpretation of information-focus and ground, and given particular content which is inconsistent with this literal interpretation, hearers will repair the discrepancy through inferencing. Another way to state this point is that the information-focus content, the ground content and perhaps the relation will support distinct kinds of inferences. This is the central idea of Wilson and Sperber (1979).

(13) *Who did they surrender to?*
    They surrendered to THE RUSSIANS

(14) Who surrendered to the Russians?

As was mentioned, the ground is an open proposition which may be presupposed in a variety of senses. Prince (1986) mentions several distinct kinds of presupposition which arise from various syntactic constructions: explicit in prior discourse, inferrable from prior discourse, currently in hearer's consciousness and generally known. The retrieval of an open proposition from a file card, discussed earlier as the interpretation of ground, corresponds only to the first kind of presupposition. One modification required, then, is that the retrieval should be from a particular source depending on the construction used, either from the file cards,

from the hearer's awareness or from the hearer's general knowledge. Assume that these other sources are available and are also structured as file cards. Further, assume that the ground of canonical sentences such as (9) should be retrieved as inferrable from prior discourse. For this example, the retrieval will be successful. The prior discourse establishes that the Germans were surrendering to the speaker's battalion and from this it can be inferred that who they wanted to surrender to is under discussion.

In many cases, the retrieval of the open proposition from the required source fails. The simplest way to address the failure is accommodation (Lewis 1979), adding the expected ground to the source. In some cases, accommodation is not appropriate and an inference must be made to connect the ground to the source. These inferences arise from the ground content because it is intended to be recognized as the ground, i.e. as a restatement of or a connection to the discourse context.

In (15) (adapted from the Brown corpus), for instance, a news commentator suggests the sarcastic reply to Khrushchev. As shown in (16), the subject is the information-focus. The literal interpretation of the ground is that someone playing the marimba with his shoes in the UN is retrievable as inferrable from the prior discourse. This retrieval will fail. Accommodating the failure would add marimba playing to the discourse as if it had been discussed earlier. But this action cannot be construed as being under discussion. Because playing the marimba with shoes is marked as being under discussion, it requires an inference to connect it with what actually is under discussion, confrontations with Khrushchev. Marimba playing must be recognized as a metaphor for table banging. In order to make sense of this comment, the hearer recognizes, in virtue of the fact that it is presented as ground content and it cannot be accommodated, that he does know of an incident which could be described that way. The hearer will make the analogy between playing the marimba and banging on the table with a shoe and then accommodate the ground by assuming that the shoe banging incident is under discussion.

(15) *Khrushchev: Fools! What do you think you are doing?*
    Commentator: WE aren't playing the marimba with our shoes in the United Nations

(16) $[_R \notin] [_A$ we$] [_F \lambda x \ (x$ play the marimba *etc.*$)]$

This discussion suggests several components needed to interpret the ground. Since what is on the file cards are simple propositions rather than open propositions, it must be specified what it means to retrieve an open proposition from the file card. The simplest view to adopt is that it will be a proposition which matches the open one, except that the variable is instantiated with

one of the alternatives or a general term such as *something*. What is inferrable from prior discourse needs to be specified. Further, a mechanism for rejecting accommodations and inferring another ground is needed. With these components, the ground is interpreted by:

*RETRIEVE ground from source
  (source specified by construction)
*if that fails, accommodate ground
*if that fails, infer other ground and accommodate it

The semantics of the information-focus and its relation to ground are reflected as one or more entries on the file card. One entry will be, in either polarity, the proposition formed by substituting the information-focus into the ground. The polarity of this entry and what other entries should be made depend on the relation. The affirmative and negative relations specify the single entry in different polarities, while the *only* relation specifies an entry for each alternative to the information-focus. Using examples which minimally contrast with (9), the file card entries are in (17)-(19).

(17) They wanted to surrender to THE RUSSIANS
  __ want to surrender to d_4

(18) They didn't want to surrender to THE RUSSIANS
  ¬__ want to surrender to d_4

(19) They only wanted to surrender to THE RUSSIANS
  __ want to surrender to d_4
  ¬__ want to surrender to d_n (=the British)
  ¬__ want to surrender to d_n (=the Americans)

(20) They even wanted to surrender to THE RUSSIANS
  $[_R$ *least-likely, non-unique*-$\in][_A$ $d_4]$
  $[_F$ $\lambda x(d_2$ want to surrender to $x)]$

In addition to these logical entries, there are two kinds of implicatures based on the relation of information-focus to ground. Because implicatures do not affect truth conditions, they are special entries on the file cards. That is, the embedding function which determines whether the discourse is true in a model must ignore the special implicature entries. First, conventional implicatures are contributed by focus particles such as *even* or *also*. These particles are analyzed as modifiers or comments on the logical relation. *Even*, for example, contributes the two modifiers shown in (20). As a result, one regular and two special entries go on the d_2 file card. Second, scalar implicatures (Hirschberg 1985) may relate the alternatives to the frame. Contextual factors determine whether scalar implicatures should be generated. For instance, if the alternatives are ranked in a relevant way, then it is implicated that stronger values than the associate do not hold. Or, if the relation of the alternatives to the ground is salient, then it is implicated that the alternatives instantiate the ground with opposite polarity. For

example, (21) has the information structure shown in (22). The alternatives to the associate will be the set in (23). The relation of the alternatives to the ground has been explicitly questioned, and so the implication that the alternatives cannot instantiate the ground will arise.

(21) Q: *Do you have Lana Moro or Bernat yarns?*
  A: We have CASSINO
  (cited in Hirschberg 1985:58)

(22) $[_R \in] [_A$ Cassino] $[_F$ $\lambda x($we have $x)]$

(23) {Lana Moro, Bernat, Cassino}

Now consider the pragmatic component of relating the information-focus to the ground. Pragmatically, the interpretation is as the informative content. As was noted earlier, the notion of informativeness expressed by the update instructions is too literal for all cases. It is the same notion which underlies the question test as a diagnostic for information-focus. Under this analysis, the earlier example has the information structure it does because it could be used to answer the question in (24). Arguably, however, it is being used to answer the question in (25). The literal view of information-focus must be extended from supplying an unknown value to making the point of the utterance, which may require inferencing (Wilson and Sperber 1979). In some cases, the point will be to supply the hearer with a previously unknown value (or non-value) to the ground. In other cases, the information-focus may be literally uninformative and motivate inferences. While the general mechanism which generates the inferences that supply the point of the utterance from the relation and information-focus is ill-understood, it is related to the inferences that specify the coherence relations discussed by Hobbs (1985) and Mann and Thompson (1987). That is, making the point of the utterance overlaps with making the utterance coherent with the immediately previous discourse.

(24) *Who did they want to surrender to?*
  They didn't want to surrender to THE RUSSIANS

(25) *Why did they swim the river to surrender to us?*

One fairly well-understood class of these inferences is the scalar implicatures mentioned above. Note that the exchange in (21) is entirely felicitous in a setting where the clerk stands in front of a conspicuous, clearly marked display of Cassino yarn. The alternative brand's filling the open proposition is marked as informative, although in the assumed setting it cannot possibly be literally informative. The information-focus does not directly provide the information requested. Therefore, the customer infers that this was marked as the point because it is the most the clerk could say. The customer, based on the information-focus content

and the fact that it was marked as information-focus, infers that the direct answer to her question is negative.

In short, the relation-associate-frame structures which underlie sentences receive both a semantic and a pragmatic interpretation in the process of discourse incrementation. The truth conditions are expressed as a list of predications on file cards. The pragmatic interpretation has both a literal and an extended version. The literal interpretation is that the ground is under discussion and the information-focus' relation to it is informative. When the content of the information structure constituents cannot be construed this way in a particular context, the pragmatic interpretation is extended through inferencing. From this perspective, the information structure serves the function of differentiating the total content into increments of information for the purpose of inferencing. Given an utterance of the same basic sentence in the same context, a shift in its information-focus will affect the inferences it supports.

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