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Sources of Expectation in Concession

Introduction. Progress in pushing the state of the art in major text processing areas such as information extraction is hindered by a lack of practical algorithms for deep semantic processing. At the discourse level, while attempts have been made to automatically recognize discourse relations, it is less clear how this information can be used in practical applications. Our work is motivated by two basic questions: a) what kind of inferences can we draw when we identify a discourse relation? and b) what kind of semantic representation will facilitate information rich inferencing? We start this line of work with the study of concessive senses in PDTB (Prasad et al., 2008) (Miltsakaki et al. 2008). Concession is a particular semantic relation between the interpretation of one clausal argument that creates an expectation and the second clausal argument which explicitly denies it. Prior work on formalizing the semantics of Concession recognizes and analyzes two subtypes, *direct* and *indirect* (Winter and Rimon, 1994). This distinction corresponds, roughly, to the oft-cited distinction between "denial of expectation" and "concessive opposition" respectively (Lakoff, 1971), (Lagerwerf, 1998), (Korbayova and Webber, 2007). In direct concession shown in (1), a general entailment is presupposed, paraphrasable as "Beautiful women usually get married". Because of this rule, "Great Garbo was considered the yardstick of beauty" directly triggers the expectation that she married, which is *explicitly* denied in **Argd**[1]. On the other hand, in (2), "not having a car" does not entail "not having a bike". In this case, the general rule is probably "not having a car implies being less mobile", which is *indirectly* denied in **Argd**, as having a bike implies being mobile.

(1) Although **Greta Garbo was considered the yardstick of beauty**, *she never married*.
(2) Although **he does not have a car**, *he has a bike*.

So far, logical accounts of Concession have focused on how the expectation is *denied*. We are interested in how the expectation is *created*, i.e. in the "general entailment" that must hold in the context in order to trigger the expectation. Characterizing such an entailment is crucial to derive appropriate inferences.

Sources of expectation in PDTB. PDTB 2.0 includes 1193 tokens of explicit connectives annotated as "Concession". The most common concessive connective is "but" (508 tokens), followed by "although" (154 tokens). We analyzed 1000 of these tokens, and we identified four types of sources of expectation: **Causality**, (nonmonotonic) **Implication**, **Correlation**, and **Implicature**. (3.a-d) show four examples:

(3.a) **This meeting "put in motion" procedural steps that would speed up both of these functions**. But *no specific decisions were taken on either matter*. (Causality)
(3.b) Although **working for U.S. intelligence**, *Mr. Noriega was hardly helping the U.S. exclusively*. (Implication)
(3.c) *The Treasury will raise 10 billion in fresh cash by selling 30 billion of securities*. But **rather than sell new 30-year bonds, it will issue 10 billion of 29 year, nine-month bonds**. (Correlation)
(3.d) Although **it is not the first company to produce the thinner drives**, *it is the first with an 80-megabyte drive*. (Implicature)

In (3.a), "the procedural steps" that were "put in motion" during the meeting" (defeasibly) cause "taking important decisions in both of these functions". Note that in this case the concessive relation allows the

[1] In all the examples, the argument in boldface is the one that creates the expectation, while the one in italics is the one that denies it. We refer to them as **Argc** and **Argd** respectively.

inference that meetings which define procedural steps on specific topics are causally related with decision taking related to the same topics. The example shown in (3.b) involves nonmonotonic implication rather than causality. In (3.b), it is strange to say that *working for U.S. intelligence* normally "causes" *helping U.S. exclusively*. Rather, the former seems a kind of necessary condition or job requirement for the latter: *working for U.S. intelligence* implies *helping U.S. exclusively*. In (3.c), the triggered expectation arises because the eventuality **Argc** *usually* occurs with the denied eventuality described in **Argd**. In (3.c), a suitable interpretation is that the Treasury usually raises money by selling new 30-year bonds while in this case, a different strategy was adopted. Finally, (3.d) does not appear to fall in neither one of the three categories, nor does it seem that the expectation is identified on semantic grounds only. Rather, it seems that the argument is insufficient/irrelevant with respect to the satisfation of speaker's intentions, i.e. communicating what is the property of drivers which is really worth noting in that context.
Since those cases cannot be accounted for with formal semantics, we tentatively use the label 'Implicature' to refer to them. In the logical formalization below, we avoid considering this case.

Annotation study. On the basis of the above observations, we provided refined sense annotations for 1000 concessive tokens with the four new labels. Two trained annotators, who were given free descriptions of the semantics, annotated the tokens. The task was to select the label that best described the relation between the argument triggering the expectation and the triggered expectation. The kappa statistic yielded .8 agreement, which is within the range generally accepted as an indicator of substantial inter-annotator reliability. The most common source of expectation comes from causal relations (41.6%), followed by Implication (28.7%), Correlation (19.4%) and Implicature (10.3%).

Logical account. To enable inferencing in automatic text processing, we need to build efficient semantic representations for the interpretation of discourse relations. We do so by utilizing the basic principles of Hobbs's 2005 logic framework which builds on the Davidsonian's notion of Reification. Natural language statements are formalized such that eventualities (i.e. events or states) correspond to constants or quantifiable variables of the logic. Hobbs' distinguishes two parallel sets of predicates: primed and unprimed. The unprimed predicates are standard first order logic predicates commonly used in logical representations. For example, *(give a b c)* asserts that a gives b to c in the real world. The primed predicate represents the reification of the corresponding un-primed relation. The expression *(give' e a b c)* says that e is a giving event by a of b to c. Eventualities may be possible or actual. In Hobbs', this is codified via a unary predicate Rexist that holds for eventualities really existing in the world. To give an example cited in Hobbs, if I want to fly, my wanting really exists, but my flying does not. This is represented via the conjunction $(Rexist\ e) \wedge (want'\ e\ I\ e_1) \wedge (fly'\ e_1\ I)$. In Hobbs' framework, every relation on eventualities, including logical operators, causal/temporal relations, etc., may be recursively reified into another eventuality. This allows us to build logic representations for discourse interpretations that are simple to use for deciding what inferences are allowed. Drawing from Hobbs', we proposed a preliminary logical account of Concession arising from Causality in (Robaldo et al. 2008). In here, we revise this logical account and we propose the following formula for representing the meaning of (3.a):

(exist (c_a^c c_c e_c e_e e_d) (Rexist c_a^c) ∧ (partialInstance c_c c_a^c) ∧ (cause' c_c e_c e_e) ∧ (Rexist c_c) ∧ (Rexist e_c) ∧ (Rexist e_d) ∧ (inconsistent e_e e_d))	**Reference of the eventualities**: e_c = "The meeting put in motion procedural steps" c_a^c = "Important steps causes taking decisions" e_e = "Specific decisions were taken" e_d = "Specific decisions were not taken"

c_a^c is a general causal rule that holds in the context and instantiates in a contingent causal rule holding between e_c and e_e. The latter is inconsistent with e_d, which directly comes from **Argd**.

The semantics of Implication and Correlation differs only in the general rule, which in these cases indicates a non-monotonic Implication and a likely trend respectively, rather than Causality. The formulae representing the meaning of (3.b) and (3.c) are:

(exist (i_a^c i_c e_c e_e e_d) (Rexist i_a^c) ∧ (partialInstance i_c i_a^c) ∧ (nonMonotonicIf ' i_c e_c e_e) ∧ (Rexist i_c) ∧ (Rexist e_c) ∧ (Rexist e_d) ∧ (inconsistent e_e e_d))	**Reference of the eventualities**: e_c = "Mr. Noriega worked for CIA" i_a^c = "Who works in CIA should help USA only" e_e = "Mr. Noriega helped USA only" e_d = "Mr. Noriega did not help USA only"

(exist (i_a^c i_c e_c e_e e_d) (Rexist i_a^c) ∧ (partialInstance i_c i_a^c) ∧ (nonMonotonicIf ' i_c e_c e_e) ∧ (Rexist i_c) ∧ (Rexist e_c) ∧ (Rexist e_d) ∧ (inconsistent e_e e_d))	**Reference of the eventualities**: e_c = "The Treasury will sell 30 billion of securities" i_a^c = "The Treasury usually sells yearly bonds" e_e = "The Treasury will sell 30-year bonds" e_d = "The Treasury will not sell 30-year bonds"

Note that, in these cases, it should be not inferred the existence of a causal relation between the eventuality denoted by **Argc** and the raised expectation, contrary to what is done in every other current logical account of concessive relations.

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