A Procedure for the Selection of Connectives

How Deep is the Surface?

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ABSTRACT

We present an implemented procedure to select an appropriate connective to link two propositions. Each connective is defined as a set of constraints between features of the propositions it connects. Our focus has been to identify pragmatic features that can be produced by a deep generator to provide a simple representation of connectives. Using these features, we can account for a variety of connective usages. We describe how a surface generator can produce complex sentences when given these features in input. The selection procedure is implemented as part of a large functional unification grammar.

Topic area: language generation

1. Introduction: Motivation

A language generation system that produces complex sentences must be able to determine which connective (e.g., *"but,"* *"although,"* *"since,"* *"because,"* *"and,"* etc.) best links its embedded sentences. In the framework of a generation system comprising two components, a deep component that decides "what to say" and a surface component that decides "how to say it" [14, 13], problems arise in determining exactly *where* the connective should be selected. Since connectives provide clues about the structure of a text (i.e., they indicate the relationships between its parts), yet are linguistic entities (i.e., words), their selection appears to be positioned at exactly the junction of these two components.

There are two extreme approaches to distributing the decisions required to produce a connective between the deep and surface modules. At one end, the deep component can provide a rich description of the relation between the propositions and the surface component can realize this well defined relation as a connective. Pushed to the limit, this approach would require the deep component to provide the lexical item to be used as a connective. This is the approach taken in systems using rhetorical predicates or relations [14, 11, 4, 10].[1] Very few of these systems have focused on the problem of connective generation, but take advantage of a one to one correspondence between relations and connectives to generate some connectives. This approach puts the entire burden of connective generation on the deep component. Furthermore, it sidesteps the problem of defining criteria for connective selection. Definition of a connective will be the same as a definition of a rhetorical relation or predicate. Such definitions have been made subjectively and not for the purpose of selecting connectives. While such relations are necessary for other tasks, it is questionable whether they are adequate for the wide variety of connective usages.

The other approach is to relieve the deep component of the connective selection task, and have a very weak description of the relation between the two propositions sent to the surface component. The surface component is therefore left with a difficult decision and no input upon which to base it. It must arbitrarily choose a connective - which will most likely not be appropriate.

Both extremes are undesirable. In this paper, we define an intermediary representation between deep and surface that is rich enough to distinguish among a broad set of connectives, but weak enough to be compatible with many different domain dependent deep modules. We call this representation an "interpretative format" (IF). We present an implemented procedure to select an appropriate connective to link two propositions given interpretative formats for the propositions. In this paper, we demonstrate how our surface component uses IFs to describe the usage conditions of the four connectives: *but*, *although*, *since* and *because*. The same technique has been extended to other connectives as well but is not reported here.

Each connective is described as a set of constraints between the features of the IFs representing the propositions it connects. This allows for a simple representation of the connective but one that captures a wide variety of different uses. An interpretative format contains four pragmatic features in addition to the propositional content and speech act of the proposition. These are *argumentative orientation* [5], the set of conclusions that the proposition supports; *functional status* [23], its structural relationship to the remaining discourse segment; *polyphonic features* [5], indicating whether the speaker attributes the utterance to himself or to others; and a *thematization procedure*, which describes the common relation between the propositions. After discussing previous work on the description of connectives (Section 2), we define these features in some detail and show how to formally represent connectives (Sections 3 to 6). Finally, we describe our implementation of the connective selection procedure

[1] From published reports, we assume these are the primary generation systems that make any attempts at connective generation.

in Section 7.

2. Previous Work on Connective Description

Work on the structure of discourse [3, 22, 7] has identified the role of connectives in marking structural shifts. This work generally relies on the notion that hearers maintain a discourse model (which is often represented using stacks). Connectives give instructions to the hearer on how to update the discourse model. For example, "now" [9] can indicate that the hearer needs to push or pop the current stack of the model. When used in this manner, connectives are called "cue (or clue) words." This work indicates that the role of connectives is not only to indicate a logical or conceptual relation, but that it also has to do with the structural organization of discourse. The distinction between cue and non-cue usages is an important one, but that is the only distinction this work provides. It does not address the problem of choosing a connective for non-cue usages, and furthermore the structural indication (which often has the form of just push or pop) under-constrains the choice of a cue word - it does not control how to choose among the many markers indicating a *pop*.

Halliday [8] proposes that the connection between clauses can be described on three dimensions: *taxis*, *expansion* and *projection*. *Taxis* refers to the respective statuses of the connected clauses: a paratactic relation links two proposition of equal status, in an hypotactic relation one proposition "depends" on the other. The *expansion* system indicates how one proposition modifies the other - whether it adds to, elaborates, or enhances it. The *projection* system indicates how the locutor presents the proposition - whether it is mentioned from previous discourse, or presented as an idea or a fact. This model is implemented in the *Nigel* system [12]. It provides a fine-grained classification of a broad set of connectives. There are several problems with Halliday's approach, however. The first is the use of labels describing the type of relation between two propositions within the *expansion* system. Such labels are similar to rhetorical relations or predicates and, as we have argued, they simply place the burden of determining which connective to use elsewhere. At the very least, a deep generator will have to have a good definition of each of these relations and such definitions, to date, have tended to be subjective. Furthermore, Halliday's model does not account for cue usages of connectives. This is because the systems do not describe the nature of the propositions the connective links, whether semantic propositions, discourse segments, or some other sort of entity.

Like Halliday, we also attempt to provide a fine-grained characterization of connectives and our model has features that are similar to Halliday's *taxis* and *projection* systems. However, the use of argumentative features and a thematization procedure allows us to avoid reliance on rhetorical relations and to capture cue usages of connectives. We now turn to a detailed discussion of each of the features that we use.

3. Distinction But-Although vs. Because-Since: Argumentative Features

3.1. Cause and Concession vs. Argumentation

One distinction between the four connectives is that two connectives express a causal relation ("because" and "since"), and the others express a concessive relation ("but" and "although"). Rather than rely on such labels, we use Ducrot's theory of argumentation [1] to capture these distinctions in a general way. It states that utterances serve as arguments for (implicit or explicit) conclusions. For example, the utterance "he is smart" can serve as an argument for the proposition *he succeeds at exams*. Using argumentation, we can describe *cause* as a relation between an utterance and a conclusion it can support and *concession* as a relation between an utterance and the conceptual negation of a conclusion it can support. Thus, in (2) below "he is smart" can serve as an argument for "he passed his exam," and we can use a causal connective. In (1), "he failed his exam" can serve as an argument for "he is not smart," so we can use a concessive connective with "he is smart."

(1) He failed the exam, although he is smart.
(2) He passed the exam because he is smart.

The fact that P is an argument for or against Q is not a property of the information conveyed by P and Q, nor can it be derived from the knowledge of the hearer alone, given this information. Different argumentative relations between the same propositions can be created by the use of different linguistic devices in different contexts. For example, (3) can be used to illustrate the inadequacies of a particular exam. Here, the same sentence "he is smart" is used as an argument for the conclusion "he failed the exam." Therefore, we require the deep module to provide in the IF (the input to the surface module) the argumentative relations that must be conveyed by the utterance.

(3) Take Jack, for example. Since he is smart, he failed the exam.

3.2. Formal Representation of Argumentative Features

An IF contains a feature AO, *argumentative orientation*, describing the ordered set of conclusions (i.e., a scale) supported by the utterance to be generated. An AO contains the following sub-features: (1) *scale* is a gradual property[2] defined in the domain (for example, degree of intelligence); (2) *proposition* is a template describing the general form of all members of the set of conclusions (the *argumentative scale* -- AS); (3) *projector* identifies the constituent of *proposition* that is related to the *scale*. For example, one AO needed to generate example (2) is shown in figure 3-1. The projected constituent is underlined in the English gloss. The set of propositions represented by this description, is obtained by moving the projected constituent along the scale (producing for example, he is smart, he is stupid, ...).

```
;; I want to say something about how smart a particular person is
(AO ((scale smart)
     (proposition ((process-type attributive)
                   (carrier Person1)))
     (projector (attribute))))
```

Figure 3-1: Formal features to generate (2)

Topoi, gradual inference rules [21] of the form "the more X is A, the more Y is B," are needed to explain the connection between the AOs of two conjoined utterances. For example, in (2), one needs the knowledge that "the more X is smart, the more X succeeds at exams." In the full paper, we will show the representation and use of topoi. For now, note that we use "+" to indicate more and "-" to indicate less. Thus, if the scale in Figure 3-1 is given the unique name S1, and we assume a second AO representing success at exams named S2, the topoi for example (2) would be +S1, +S2 (the more Person1 is smart, the more Person1 succeeds at exams), while a topoi +S1, -S2 would represent "the more Person1 is smart, the less Person1 succeeds at exams."

The argumentative meaning of a connective is described as a set of constraints between the AOs of P and Q. Given S1 and S2, the scales of the AO of P and Q, there is a concessive relation between P and Q if a topos (+S1,-S2) can be found. If a topos (+S1,+S2) can be found, P and Q are in an argument-conclusion relation. We also check in the grammar that the *propositions* are compatible in the AOs and the topoi.

Using argumentative features in our description of the connectives allows us to request the same knowledge from the deep

[2]Gradual properties are denoted by an adjective that can be modified by "very."

generator to generate both concessive and causal relations. The task of distinguishing between these two classes is therefore left to the surface component.

4. Distinction But vs. Although: Functional Status

4.1. Directive vs. Subordinate Acts in Discourse

"But" and "although" can be distinguished by their influence on the discourse structure in which they are embedded. We draw upon the theory of conversation organization presented in [23, 15] to explain this distinction. Roulet's model describes conversation as a hierarchical structure and defines three levels of constituents: *speech acts*, *move* and *exchange*. A *move* corresponds to a turn of a speaker in a conversational *exchange* between two or more speakers. It is made up of several *speech acts*. In the structure of a move, one speech act is *directive*; all others are *subordinate* - they modify or elaborate the *directive* act. Intuitively, the *directive* act is the reason why the speaker started speaking. It constrains what can follow the move in the discourse. While a move may consist of several subordinate speech acts in addition to the directive act, the directive controls the possibilities for successive utterances. Thus, it determines what is accessible in the structure of the preceding discourse.

To see how this characterization of discourse can explain the distinction between "but" and "although," consider the following examples:

(4) He failed the exam, although he is smart.
(5) He failed the exam, but he is smart.
(6) Let's hire him.

Both (4) and (5) express a contrastive relation between the two propositions. But, the sequence (5,6) is coherent, whereas the sequence (4,6) sounds peculiar in most situations. This can be explained by the fact that in "P but Q" Q has directive status while in "P although Q," Q has subordinate status. In (5) then, "he is smart" has directive status, whereas in (4) it is subordinate. Therefore, the argumentative orientation of the complex sentence as a whole in (4) is the AO of "he failed the exam" and it is the AO of "he is smart" in (5). The conclusion (6) is only compatible with "he is smart."

This distinction is similar to Halliday's taxis system but operates at a different level. In Halliday's description, "but" expresses a *paratactic* relation, meaning that P and Q have the same status. While they do have the same syntactic status ("but" is a conjunction), they have a different influence on the following discourse. We therefore require the deep generator to indicate the "point" of a move, but to leave the syntactic status of each proposition unspecified. This more delicate decision is made by the surface generator.

4.2. Formal Representation of Functional Status

The Interpretative Formats of the constituents of a move contain a feature FS describing their functional status. The value of FS can be either *directive* or *subordinate*. When it is *subordinate*, it can be refined to either *argument*, *preparation* or *pre-sequence*. (Values are different within the *exchange*.) For example, the IF representation of example (4) is shown in figure 4-1. In the description of connectives, we indicate the status that the connective gives to P and Q. "But" and "although" are therefore distinguished by the status they give to the proposition they introduce: in a complex PcQ, Q is directive when c="but" and subordinate when c="although."

```
(P ((FS directive)                          (Q ((FS subordinate:argument)
    (Prop-Content [Jack failed the exam])))     (Prop-Content [Jack is smart])))
```

Figure 4-1: FS features to generate sentence (4)

5. Distinction Because/Since: Polyphonic Features

5.1. Polyphony

"Because" and "since" have the same argumentative behavior, and give the same functional status to the propositions they connect. Their different usages can be explained using Ducrot's theory of *polyphony* [5]. Ducrot distinguishes between the *locutor* (the physical source of the utterance) and the *utterers*[3] (entities presented by the locutor as responsible for the utterance). This distinction is necessary to precisely determine to whom each part of an utterance can be attributed.
Using this theory, the difference between "because" and "since" is as follows: in the complex "P since Q," the segments P and Q can be attributed to different utterers ("since" is polyphonic), whereas in "P because Q," they must be attributed to the same utterer ("because" is monophonic).

Others have described "because" and "since" only by noting distributional differences such as:

1. To answer a "why" question, only "because" works:

   A: Why did Peter leave?
   B: Because he had to catch a train.
   B: *Since he had to catch a train.

2. "Because" has a tendency to follow the main clause while "since" has a tendency to precede it [20, 11.37].
3. "because"-clauses can be the focus of cleft sentences [20]:

   It is because he helped you that I'm prepared to help him.
   *It is since he helped you that I'm prepared to help him.

The distinction given/new gives one interpretation of these differences: "because" introduces new information, whereas "since" introduces given information (where given is defined as information that the listener already knows or has accessible to him [8]). Halliday also indicates that, in the unmarked case, new information is placed towards the end of the clause. And indeed "because" appears towards the end, the unmarked position of new information, and "since" towards the beginning. "Because" can be the focus of an It-cleft sentence which is also characteristic of new information (cf [18] for example). "Because" can answer a why-question, thus providing new information to the asker. Presenting given information in response could not serve as a direct answer.

There are many different types of given information, however [19]. Polyphony provides a precise formalism for describing how it is given. It defines given as information that is presented as mentioned by another utterer. That utterer can be one of the locutors, in which case mentioning his discourse is similar to indirect speech, or it can be an existing discourse, such as the Scientific discourse ("Earth is round"). The ability to distinguish how the "since" clause is given (i.e., which utterer contributed it) is crucial to correct use of sentences like (7).

(7) Since you are tired, you must sleep. (from a father to his child)

In (7), the speaker presents the hearer as the source of "you are tired," and uses the fact that the hearer has previously uttered this sentence as the argument for "you must sleep." If the hearer is not the source of the sentence, this strategy cannot convince him to go to sleep. Given/new is therefore a polyphonic distinction, and polyphony allows a finer description of the distinction.

---

[3] In French, enonciateurs

In summary, "because" and "since" have the same argumentative definition and same Functional Status definition, but they have different polyphonic definitions. We assume that the deep generator is able to reason about what information has been presented by each participants in a conversation, and to determine the perspective of the locutor on a given piece of information.

5.2. Formal Features to Represent Polyphony

In our implementation we use the feature *Utterer* to describe the polyphonic status of an utterance. It contains the following sub-features: *name*, *type* and *link-locutor*. *Name* uniquely identifies utterers. Utterers represent a coherent argumentative perspective, meaning that they use a consistent set of topoi in their discourse. This set of topoi is a partition of the database of topoi maintained by the locutor. The feature *name* points to such a partition. *Type* distinguishes between two sorts of utterers: those that represent real locutors - identified persons - and those that represent abstract discourses - like the "scientific discourse." In the first case, the value of the feature *type* is *locutor*, in the second, it is *discourse*.[4] Finally, the feature *link-locutor* indicates how the locutor considers the utterer: its value can be *Identify* (the utterer is the locutor), *Distant* (the locutor puts distance between him and the utterer). When necessary, *Distant* can be refined into *Support* or *Oppose*, depending on the opinion of the locutor on the sentence mentioned.

For example, the polyphonic features used to generate "since Jack is smart (P), he failed the exam (Q)" are shown in figure 5-1.

```
(P ((Utterer ((Name U1)                    (Q ((Utterer ((Name U2)
             (Type Locutor)                             (Type Locutor)
             (Link-locutor Distant)))))                 (Link-locutor Identify)))))
```

Figure 5-1: Polyphonic Features producing a 'since'

6. Thematization Procedure: Cue vs. Non-cue Usage

The most basic constraint on the use of all connectives, is that the two related propositions say something about the same "thing." It must be possible to find a discourse entity that is mentioned in both P and Q for a connection PcQ to be acceptable. We call the set of discourse entities mentioned in an utterance the *theme* of a proposition. The constraint is that the themes of P and Q intersect. For example, in (2) "he passed the exam because he is smart," the entity in common is the person referred to by "he" in both P and Q. In simple cases, this common entity can be found among the participants in the process described by the proposition. In many cases, however, the connection is made through some *discourse* entity and not propositional content. In the full paper we will show how we explain these connections through a *thematization procedure*. We currently use the following thematization procedures in our implementation: Propositional Content (PC), Argumentative Derivation (AR) Functional Status (FS), Speech Act (SA) and Utterance Act (UA).

Thematization procedures allow us to distinguish cue and non-cue usages of connectives. When a connective links on a feature that is not the PC, it does not affect the truth conditions of the propositions, at least in the traditional view. This suggests that non-content linking is in some ways similar to the cue/non-cue distinction discussed in section 2. Our approach does therefore capture this distinction, but with several differences. It describes the structural move performed by the connective (whether it is a push or a pop, for example) using features of the "normal" (i.e., non-cue) interpretation: if C introduces a directive act, it would work as a "pop," if it introduces a subordinate act, it would be a "push." Thus, a cue interpretation of a connective

[4] [2, 17, 16] give examples of phenomena we can address by using this distinction between *locutor* and *discourse*.

differs from non-cue by the thematization procedure; cue usage would be indicated by linking on the functional status, and possibly speech act or utterance act. It remains open whether cue connectives retain all other features of non-cue usage.

7. Implementation

Our implemented surface generator takes two IFs as input, and generates a sentence PcQ when possible, with the connective chosen appropriately. The procedure is integrated in a large systemic grammar[5] expressed in a Functional Unification formalism (FUG). We have added two higher level constituents than the clause: *discourse-segment* and *utterance*. The constituent *connective* is at the same level as *utterances* and is chosen when the features of the input IFs are compared, adding constraints on the realization of the clauses. Note however that, since FUGs work with partial representations, it may be that the connective is not actually determined until the clauses are further specified. That is, not all IF features need have values on input. They may be deduced from constraints from the clause.

The FUG formalism is well adapted to the expression of most constraints needed to describe connectives. The main advantage is that the constraints can be represented separately in different regions: the grammar for connective choice has a distinct region for polyphonic, argumentative, thematic and functional status features. Figure 7-3 shows a fragment of the grammar in FUG formalism, implementing polyphonic and functional status constraints. Unification handles the interaction between these different regions transparently. Unification also allows for flexible order of decision in the grammar.

In the full paper, we will provide full details on the selection of a connective. For brevity, we simply show some additional sample sentences generated by the system in Figure 7-1 (all other examples in the paper were also generated by our system). Figure 7-2 shows the input used to generate one of these sentences. The unifier is written in Common Lisp. The complete generation of a complex sentence takes on the order of 1 second on an HP workstation (see [6] for more details on the implementation).

```
;; Polyphonic mention of a general principle: use since
Since turning the switch to the left causes the power to decrease, the transmission capacity
decreases.
;; Explanation by a new fact: use because
The transmission capacity decreases because you turn the switch to the left.
;; Subordinate act is an imperative - use but
Replace the battery, but keep the old battery.
;; Subordinate act can be syntactically subordinate - use although
Although you replaced the battery, keep the old battery.
```

Figure 7-1: Examples of sentences generated

8. Conclusions

We have shown how a small set of pragmatic features can be used as an intermediary representation between a deep and surface generator to distinguish between four connectives. Although not described here for lack of space, we have extended this technique to handle other connectives as well. Each connective is defined as a set of simple constraints between these features. Thus,"P but Q" can be used when P and Q have opposing AOs, Q is directive and P subordinate, and when P and Q have different utterers. "P although Q" is used under the same conditions, with the exception that P is directive and Q subordinate. "P because Q" and "P since Q" have the same argumentation and functional status, but "because" requires P and Q to have

[5]The grammar contains 90 alternations and implements the majority of constructions discussed in [24, Appendix B].

The transmission capacity decreases because the power decreases

```
((cat discourse-segment)
 (subordinate
  ((directive
    ((theme ~(power decrease))
     (utterer ((name u1)))
     (illocu-force ((force assert)))
     (ao ((scale value)
          (projector (attribute))
          (conclusion
           ((process-type attributive)
            (carrier ((concept power)))))))
     (prop-content
      ((cat clause)
       (process-type action)
       (concept Decrease)
       (medium ((concept power))))))))))
```

```
(directive
 ((theme ~(Transmission-capacity decrease))
  (utterer ((name u1)))
  (illocu-force ((force assert)))
  (ao ((scale value)
       (conclusion
        ((process-type attributive)
         (carrier === Transmission-capacity)))))
  (prop-content
   ((cat clause)
    (process-type action)
    (concept Decrease)
    (medium ((concept Transmission-capacity)))))))
```

Figure 7-2: Sample input to the surface generator

```
;; Functional Status: for but: P is subordinate, Q directive
(alt
 (((P ((FS subordinate:argument))) ;; but
   (Q ((FS directive)))
   (c ((lex "but"))))
  ((P ((FS directive)))            ;; other connectives
   (Q ((FS subordinate:argument)))
   (c ((lex ((alt ("since" "because" "although")))))))))

;; Polyphony
;; Contrastive connective must have different utterers, locutor supports the directive act.
;; Because: same utterer in P and Q, and in both support.
;; Since: need not be same utterer. Link-locutor(Q) un-constrained.
(alt
    (((P ((Utterer (^ ^ Q Utterer))            ;; Utterers of P and Q must be unified
      (Q ((Utterer ((Link-locutor support))))) ;; In both P and Q (now unified), support
      (c ((lex "because"))))
     ((P ((Utterer ((Link-locutor support))))) ;; since
      (c ((lex "since"))))
     ;; Contrastives
     ((optional ((P ((Utterer (^ ^ Q Utterer)))) ;; Negation: try to unify the utterers
                 (same-utterer yes)))            ;; if it works, fail explicitly
      (same-utterer none)
      (alt (((P ((Utterer ((Link-locutor support)))))
             (Q ((Utterer ((Link-locutor oppose)))))
             (c ((lex "although"))))
            ((P ((Utterer ((Link-locutor oppose)))))
             (Q ((Utterer ((Link-locutor support)))))
             (c ((lex "but")))))))))
```

Figure 7-3: Fragment of the grammar for connectives

the same utterers, while "since" does not. The use of a thematization procedure allows these definitions to account for a variety of usages, including cue usages, when the conjoined propositions are not linked by propositional content.

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