Ordering And Focusing In An Architecture For Persuasive Discourse Planning

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Abstract.

In this paper, an account is presented of two crucially important aspects of natural language argumentation: the maintenance of coherency and the ordering of argument components. The account sits in an architecture based upon a hierarchical planner which, at the highest level of abstraction, generates an abstract plan describing a coherent argument structure. This plan is then refined to enhance its persuasiveness in the specific context of hearer beliefs, attitudes and capabilities. The planning process explicitly represents focus manipulation operations, and this approach facilitates both the tracking of the hearer's attentional state, and generation of a number of surface features in the text. The effect that ordering has on persuasive discourse, over and above ensuring coherency, is considerable. For appropriate and effective orderings to be planned, it is necessary to impose a number of clear restrictions on both the scope and the substrate of the reordering process. The resulting functionality can be shown to generate plans which closely resemble structures found in natural argument.

1 Introduction

This paper builds upon the work presented in [Reed *et al.* 1996a], in which an architecture is proposed for the generation of natural language argumentative discourse: this architecture is hierarchical in nature, reflecting the distinct, though inter-related, levels of structure within arguments. The part of argument synthesis which is concerned with the resolution of syntax, expression and morphology comprises the lowest level of the architecture and represents the interface to the LOLITA system [Smith *et al.* 1994]. Above this lowest level sits functionality based upon Mann and Thompsons's Rhetorical Structure Theory [Mann & Thompson 1986], and then above this are two complimentary levels, Eloquence Generation (EG) and Argument Structure (AS), upon which the current work concentrates. The AS level is responsible for producing the logical form of the argument employing 'logical' operators, fallacy operators and inductive operators, acting upon predominantly intentional data structures. This form is then augmented and modified by the subordinate Eloquence Generation (EG) level, which employs heuristics based upon rhetoric and contextual parameters, and is concerned with such properties of a discourse as its length, detail, meter, vocabulary, enthymeme contraction, use of repetition, alliteration and so on.

The generation of natural language argument is attracting increasing interest due to its wide ranging applicability: to furnish an expert systems with a means to producing cogent justification [Paris 1991]; to improve agent negotiation [Sycara 1989, Reed *et al.* 1996b, Parsons & Jennings 1996]; to assist in medical decision making [Fox & Das 1996]; to critique user decisions [Rankin 1993]; etc. Furthermore, the task of generation is aided by the fact that argument is often more structured than other forms of natural language, and this can be exploited in designing an appropriate architecture by comparing generated structures with those found in natural language[1].

The analysis of natural argumentation can thus play an important verification role for an architecture for generation, and consequently, the type of analysis employed has significant ramifications. In this work, a standard approach has been adopted, whereby premises together contribute either conjunctively or disjunctively to a conclusion, and premises may themselves be supported by further argumentation. Such analyses are found in numerous texts (eg. [Freeman 1991]), and offer advantages of clarity and simplicity, despite being somewhat less expressive than alternatives such as

[1] A corpus of NL arguments has been assembled with examples drawn from scientific papers, advertisements, editorial commentary and 'letters to the editor', to enable these comparisons to be made.

Toulmin schema [Toulmin 1958]. It is interesting to compare such an approach to analysis with the notation used in generation of arguments by, for example, Zukerman *et al*. [McConachy & Zukerman 1996, Zukerman *et al*. 1996], who propose *argument graphs*, in which nodes represent propositions, and arcs the relations between them (including sourcing relations). Argument graphs express rather more than the standard argumentation analyses (for the latter do not specify the relations holding along the arcs), but are unable to distinguish between disjunctive and conjunctive contributions, which significantly restricts their application to just those examples in which the distinction is unnecessary.

Argumentation-theory analyses also highlight the role played by enthymemes and other implicit information, by introducing a stage of *reconstruction*, which precedes the analysis proper. The reconstruction of an argument is undertaken to varying degrees (see, for example, the pragma-dialectical approach [vanEemeren & Grootendorst 1992]) to introduce missing, tacit information, so that an accurate analysis of the structure of the argument can take place. This suggests that some 'original' structure of the argument contains this tacit information. Therefore, the generation of an argument must first involve the generation of a discourse plan replete with this information which at a later stage is suppressed and made tacit to ensure that the resultant text is appropriately brief, succinct, or is simply not repetitive.

2 Planning

In line with the majority of current NLG research, the task of generating argument is seen as one of planning, since the

> "*generation originates with one or more communicative goals and ends with a (more or less) structured list of communicative actions (namely, sentences of words)*" [Hovy & Wanner 1996], p53

The flexibility and generality provided by the planning process is significantly more suited to the creative generation of persuasive discourse than are the schema-based alternatives. Flexibility is also the motivation for designing the system around AbNLP, rather than NOAH [Sacerdoti 1977], for although NOAH has been widely used as the basis for discourse planning [Hovy 1993], the approach forces the bulk of an abstract operator body to be composed of operators, leading to abstract operators acting as a form of schema-like 'recipe'. AbNLP is based on the use of *operator abstraction* and *encapsulation* [Fox & Long 1995], whereby an abstract operator contain goals, rather than operators, in its body (a similar approach was adopted in SIPE [Wilkins 1988], though other features of SIPE, such as its need for user intervention in the planning process, make it unsuitable for discourse planning). The planner constructs a hierarchy of abstract plans, connected together by a special operation called *refinement*. An abstract plan can be seen as a skeletal discourse, in which the overall structure is in place but none of the details of the argument have been planned. Refinement to more detailed planning levels, which is only performed when an abstract plan has been completed (that is, has no outstanding goals), must preserve the structure provided by the abstract plan. As a consequence, many choices which might have been considered during planning of an argument at the detailed level can be pruned as they become inconsistent with the abstract plan. Abstraction therefore assists in the planning of a complex argument by converging on a detailed argument from above. There is significant evidence in the literature that this form of abstraction can considerably improve the performance of a classical planner [Bacchus & Yang 1992].

Such top-down refinement in a 'pipelined' fashion has been criticised [Hovy & Wanner 1996] for being inadequate inasmuch as it ignores the possibility of decisions made at, for example, the lexical level, affecting decisions taken at the level of content selection or text structure organisation. The current work is concentrating on such a high level of pragmatic macroplanning that such interactions acting against the flow of refinement are rare. Furthermore, the criticism seems to be at least partly founded on NOAH-like planning restrictions which have been avoided through the use of AbNLP.

The planning process begins with a single goal - that of convincing a particular audience of a particular proposition. This presents something of a simplification of much real world argumentation which, as discussed in [Reed *et al* 1996a], may have secondary goals (such as 'face' goals, [Gilbert 1996]), and which may distinguish between opponent and audience (for example, one primary aim of debating house argument is to impress the audience with oratorical skill, rather than convince the dialectical opponent).

This initial goal is represented as `BEL (H, P)`, and is classified as a *communicative* goal, following [Moore & Paris 1994]; that is, it expresses intentional rather than informational content [Young & Moore 1994], describing the hearer's intentional rather than attentional state [Grosz & Sidner 1986]. Hierarchical planning at the AS level refines this initial goal using a set of operators (logical, fallacial and inductive: see [Reed *et al* 1996a] for details). This process results in a complete abstract plan of (AS-)primitive operators. By way of example, Figure 1 shows the body of the Modus Ponens operator (i.e. the operator used to describe the argumentative move (X, (X $\supset$ P) $\vdash$ P)), with the goals which cause the primitive operators to be invoked. The `BEL` goals can be fulfilled either by further planning of argumentative structure, or else by matching beliefs held in the belief model of the hearer. The `PUSH_TOPIC` and `POP_TOPIC` goals are typically fulfilled by primitive operators of the same name, and the `IS_SALIENT` goals by a corresponding primitive, `MAKE_SALIENT`.

```
Modus Ponens (H, P)

Body:  t0:   PUSH_TOPIC (P)
       t1:   BEL (H, X)
       t2:   IS_SALIENT (H, X, P)
       t3:   BEL (H, X ⊃ P)
       t4:   IS_SALIENT (H, X ⊃ P, P)
       t5:   POP_TOPIC (P)
```

Figure 1: Modus Ponens Operator Body

Thus an argument comprising just a single Modus Ponens step would be planned for at the AS level to the primitive plan of operators given in Figure 2. Each of these operators expresses a single communicative goal. Thus, in contrast to [Moore & Paris 1994], abstract communicative goals are permitted to be planned for into more refined communicative goals (rather than necessarily being refined to linguistic goals). Furthermore, the `PUSH_TOPIC` and `POP_TOPIC` goals indicate that it may be appropriate to subdivide the class of communicative goals into those that are intentional, and those that are attentional - these goals would then clearly fall into the latter category.

```
PUSH_TOPIC (p)
MAKE_SALIENT (h, x, p)
MAKE_SALIENT (h, x ⊃ p, p)
POP_TOPIC (p)
```

Figure 2: Plan of primitive operators for MP

A plan such as that shown in Figure 2 is the result of the AS level, and is passed on to the EG level. In considering anything but the most trivial of arguments, this plan is detailed and contains many more steps than would normally be explicitly and directly realised as text. However, this does not mean that the AS is creating redundant plan components, since every single component is indeed necessary for the logical structure of the argument: the EG can then subsequently determine those parts of that logical structure which do not need to be explicitly included in the text (due, say, to the hearer's ability to follow complex argumentation - a parameter whose role has been noted in [McConachy & Zukerman 1996] and [Reed *et al.* 1996a]). The EG may also reduce[2] the number of steps which are realised explicitly in order that the text is not rendered repetitive, and less persuasive as a result. The AS produces a complete, logical plan which would, perhaps, convince a completely dispassionate audience (for this reason, the result of the AS is of use in multi-agent systems where complex negotiation is only achievable through the use of argument, and in which agents are neither bound to the use of natural language, nor influenced by matters of rhetoric, [Reed *et al.* 1996b]). The task of the EG is to render that plan as persuasive as possible given parameters which crucially include reference to the beliefs, attitudes and capabilities of the hearer.

3 Focusing

It is the problem of maintaining the *focus* of an argument which makes the task of the AS of particular interest: without such a constraint, operators that describe the argument process have a monotonic behaviour - they can be applied to shift the beliefs of an audience in only one direction: from disbelief through uncertainty to belief, or, conversely, from belief towards disbelief. For in discourse, it is never desirable to plan for an effect, and then for that effect to be undone - rather, it requires only monotonic accumulation of information. Thus, the role that planning plays in discourse construction is in the development and maintenance of *coherence* as the discourse develops. A speaker must present the components of an argument in a way that allows related elements to be connected in the hearer's knowledge. An argument cannot proceed by giving pieces of information in a disconnected and arbitrary way. It is necessary to organise the argument in a way that emphasises its structure and allows the hearer to identify the inferential structure and draw the appropriate inferences.

Focusing is achieved through the use of the `PUSH_TOPIC` and `POP_TOPIC` operators, which introduce and remove propositions from the focus of attention. As in [Grosz & Sidner 1986] (and many others), the focus manipulation is co-ordinated through the use of a *topic stack*, the top of which, in this work, represents the speaker's model of what the hearer believes to be the current focus. Thus the topic stack is part of the speaking agent's cognitive state, rather than being a function of the discourse, as suggested by [Grosz & Sidner 1986]. This point is noted in [McCoy & Cheng 1991], in which it is also explained how using a focus structure located in the participants themselves allows the coherency of a dialogue to be measured in terms of the disparity between the structures held by the different

[2] The EG may occasionally also add to the plan offered by the AS: through analysis of the corpus, it has been found that occasional phrases in argument play no structural role whatsoever. These can be explained by the EG generating purely rhetorical fragments.

participants. Although this work is concentrating on monologue, one measure of effectiveness of an argument would be to compare the speaker's model of the hearer's focus structure with the hearer's actual structure.

In order that the current focus of attention can affect the organisation of argument components, the topic stack clearly needs to be available at plan-time, as well as subsequently existing at the time of plan execution. The stack has a limited role at execution (though can be used as a measure of effectiveness, as mentioned above) - clearly, however, it is essential in full dialogue where dynamic replanning in response to communication failure necessitates access to attentional facets of the current state of the argument.

Planning explicitly with topic manipulation offers a number of advantages over the more conventional approach of seeing focus as a constraint active over the planning process. The inclusion of the `PUSH_TOPIC` and `POP_TOPIC` operators in the plan produced by the AS, enables recovery of the argument's hierarchical framework at the EG level (that is, the EG has available to it the structure determined by the conventional method of argument analysis mentioned above). This structure is of use during the application of eloquence heuristics, and in particular in determining appropriate scope, with the topic manipulation operators acting as end-stops.

The topic manipulator operations also directly benefit the generation process, being in part responsible for a number of manifest phenomena, including formatting, punctuation and clue words [Cohen 1987]. For example, where a conclusion is supported by several subarguments, it is common to find in natural (written) argument that the subarguments are separated by paragraph breaks (and, at higher levels of abstraction, by blank lines and section breaks). A plan produced by the AS level which involves multiple subarguments in this way is characterised by having repeated co-occurrences of `PUSH_TOPIC(X)` followed immediately by `POP_TOPIC(X)` [3]. This feature can be directly responsible for paragraph structuring (with only minor modification required to take account of ensuring breaks occur only at suitable levels of abstraction). At a lower level of abstraction (i.e. at the level of the clauses and sentences that make up the paragraphs), the topic stack operators can be used to generate segmentation through the use of appropriate punctuation (such as semicolons delimiting suitably short premises, and forming a list). Finally, it has been shown (from an analysis point of view) that clues play a key role in argumentative discourse, conveying essential structural information to the hearer (and can be responsible for rendering a text coherent that, without them, would be incoherent) [Cohen 1987]. The topic manipulator operations in the plan produced by the AS immediately lend themselves to the generation of appropriate clues - in the first instance by nothing more than reliance upon a small group of stock phrases such as "*because*", "*therefore*", "*another reason is*", etc. For example, in a complex argument where a deeply nested subargument marks the end of several of its 'parent' superarguments, the AS plan will include a number of consecutive `POP_TOPIC` operations. In natural argumentation, such a scenario often results in a clue phrase being employed to explicitly mark which superargument is being returned to; for example, "*To return to the question of*". The generation of such a phrase can clearly be linked to the presence of multiple consecutive `POP_TOPIC` actions.

It is not the case that all clue words (or all uses of particular clue words) are best generated by the topic manipulators. For example, an argument based upon Modus Tollens leads the hearer to believe some conclusion on the basis of a particular premise; the conclusion is then shown to be false, proving the premise to likewise untrue. In natural language, the contrast between showing $P \supset X$ and then $\neg X$ is frequently emphasised through the use of "*but*", which as a consequence often indicates (to the hearer) the use of Modus Tollens. Such realisation would be dependent not upon topic manipulation, but upon a heuristic at the EG which detects Modus Tollens (or at least, detects two consecutive `MAKE_SALIENT` operators in the plan, where the second falsifies the consequent of the first).

4 Ordering

The ordering of components in an argument plays two vital roles. As pointed out in [Cohen 1987], the coherency of an argument can depend upon the order in which premises are presented (even within the range of plan structures permitted by the focusing operators). Furthermore, the concept of coherency is not dichotomous: one ordering may be *more* coherent than another. Just as importantly, it is well recognised in rhetoric that appropriate ordering can greatly enhance the persuasive effect of an argument (that is, even though two different orderings may be equally coherent, one may be more effective than the other). This point is made quite clear in [Blair 1838]:

> "*Supposing the arguments properly chosen, it is evident that their effect will, in some measure, depend on the right arrangement of them; so as they shall not justle and embarrass*

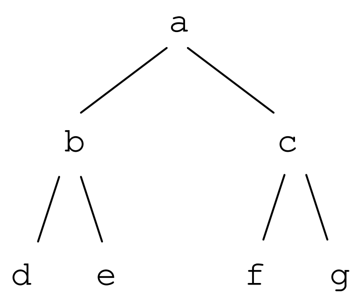
[3] This is due to a topic being pushed on to the stack inside the body of an operator - consider, for example, the Modus Ponens (MP) operator in Figure 1, which is supporting some topic P. It is not until the body of the MP is expanded (during refinement) that P gets pushed on to the stack. Thus every subargument for a particular conclusion pushes that conclusion on to the stack at its beginning and pops it off again at the end. Consequently the plan contains a pop immediately followed by a push between subarguments contributing to the same conclusion.

one another, but give mutual aid; and bear with the fairest and fullest direction on the point in view", p430

This quote also highlights the intuition that ordering should, at least in part, be the responsibility of the EG level, with its access to notions of rhetoric and eloquence. For the process of ordering to be divided between the AS level maximising coherency and the EG level maximising persuasive effect, there must be a clear means of representing the partial order enforced by the AS level. By itself, the conventional partial order notation is unable to express the hierarchical orderings which exist at different levels of abstraction, as these involve disjunctive constraints. The problem is illustrated in Figure 3.

However, when taken in conjunction with the ordering constraints imposed by the preconditions of the `MAKE_SALIENT` operator, the required representation is achievable. Each `MAKE_SALIENT` operator expresses the intention to make a proposition salient to the hearer *in the context of* a particular topic. In the first `MAKE_SALIENT` of Figure 2, for example, *x* is to be made salient in the context of *p*. The precondition of that operator specifies that *p* must be on the top of the topic stack, thus restricting the operator's position in the resultant plan. It is constraints of this type which restrict the partial order, such as that in Figure 3, and allow only those orderings which are coherent.

There are several restrictions which apply to the ordering process. Within an operator body, such as that in



Consider an argument in which the conclusion, a, is supported by two subarguments, b and c. Each of these subarguments involves two premises - d and e support b; f and g support c. Premises at one level of abstraction are unordered within the bounds of the subargument to which they contribute. Thus the pair (d, e) is unordered, as is the pair (f, g). Similarly, (b, c) is unordered - that is, the pair (d, e) may either precede or follow the pair (f, g). However, this arrangement cannot be expressed using a conventional partial order, without introducing significant redundancy.

Figure 3: The limits of partial ordering

Figure 1, there are two forms of reordering:

- Changing the sequence of premises (for example, in MP, from X then ($X \supset P$) to the reverse, ($X \supset P$) then X).

- Changing the position of supporting argumentation for either premise, such that the conclusion either precedes or follows the subargument (in MP, this means independently choosing between `BEL–IS_SALIENT` and the reverse `IS_SALIENT–BEL` for each of the two premises in the body).

In every operator which uses the topic manipulators, their position is fixed at the beginning and end of the body; all ordering must take place between them and not involve them.

However, reordering within the body alone is insufficient to account for one common form of argument in which the conclusion is positioned *between* the subarguments which support it. To enable the generation of such structure, it is necessary to amend the second form of ordering slightly, so that it applies not to a reordering of the `IS_SALIENT` and `BEL`, but of the `IS_SALIENT` and the subarguments that support the `BEL`. The `IS_SALIENT` goal corresponds to the expression of the conclusion, so in this way the interpositioning of conclusion with its supporting subarguments can be achieved. For example, the top half of the argument structure shown in Figure 3 is the standard analysis for an argument consisting of two disjunctive premises (i.e. *b* and *c* supporting the conclusion *a*). Assuming that each 'support' relation is characterised by Modus Ponens, the corresponding planning process is shown in Figure 4, below (wherein indentation indicates goal fulfilment, and the move from stage (1) to stage (2) corresponds to refinement).

At stage (1), the initial goal, for the hearer to believe *a* is fulfilled by the two MP steps. It is assumed that the information expressing these supports is available in the knowledge base, but this does not form a crucial assumption of the work: the required information could equally be provided by 'reasoning agents', such as those presented in [McConachy & Zukerman 1996]. The corresponding goal to make the conclusion salient to the hearer is fulfilled by the `MAKE_SALIENT` operator, as mentioned above[4].

After refinement, the bodies of the two MP operators are opened up for stage (2). Here, the `PUSH_TOPIC`, `POP_TOPIC` and `IS_SALIENT` goals are fulfilled by corresponding operators, and the `BEL` goals are trivially satisfied by the presence of matching information in the hearer belief model. (In fact there are several ways that `BEL` goals can be satisfied without further argumentation,

[4] The context for this outermost conclusion is indicated by an underscore and refers to some mutual common ground, such as the *mutual initial discourse context* [Thomason & Moore 1995]

```
(1)
BEL (h, a)
   MP (h, a)    X: b
   MP (h, a)    X: c
IS_SALIENT (h, a, _)
   MAKE_SALIENT (h, a, _)

(2)
PUSH_TOPIC (a)
   PUSH_TOPIC (a)
BEL (h, b)
IS_SALIENT (h, b, a)
   MAKE_SALIENT (h, b, a)
BEL (h, b ⊃ a)
IS_SALIENT (h, b ⊃ a, a)
   MAKE_SALIENT (h, b ⊃ a, a)
POP_TOPIC (a)
   POP_TOPIC (a)

PUSH_TOPIC (a)
   PUSH_TOPIC (a)
BEL (h, c)
IS_SALIENT (h, c, a)
   MAKE_SALIENT (h, c, a)
BEL (h, c ⊃ a)
IS_SALIENT (h, c ⊃ a, a)
   MAKE_SALIENT (h, c ⊃ a, a)
POP_TOPIC (a)

MAKE_SALIENT (h, a, _)
```

Figure 4. Sample planning process

including lack of opinion or knowledge in the hearer model and lack of available supporting information in the KB). The final plan of primitive operators would thus run as in Figure 5.

```
MAKE_SALIENT (h, a, _)
PUSH_TOPIC (a)
MAKE_SALIENT (h, b, a)
MAKE_SALIENT (h, b ⊃ a, a)
POP_TOPIC (a)
PUSH_TOPIC (a)
MAKE_SALIENT (h, c, a)
MAKE_SALIENT (h, c ⊃ a, a)
POP_TOPIC (a)
MAKE_SALIENT (h, a, _)
```

Figure 5. Sample plan of primitives

At the highest level of abstraction in this example, ordering could take place between the MP subarguments and the `IS_SALIENT (h, a, _)` goal in stage (1), and could place the conclusion first, last, or between the Modus Ponens subarguments. Combined with the ability to swap the order of the premises in each of the two subarguments, this offers all and only the orderings which are permissible.

The position of a conclusion with respect to its premises is one of the most important, salient and approachable problems of ordering, as can be seen from analyses in [Blair 1838, Marcu 1996, Reed *et al.* 1996], etc. The three possibilities, *pre-order* (conclusion first), *post-order* (conclusion last), and *hybrid order* (conclusion between its supporting premises) have characteristic uses: the first for where the premises are examples or analogies, or where the initial conclusion is deliberately provocative (this is discussed in [Marcu 1996], p44); the second for more complex or less convincing arguments, for 'thin end of the wedge' arguments and for grouping together premises which individually lend only very weak support to the conclusion; the last where a post-order argument requires more bolstering, or where individual premises are particularly long (such as the case where premises are supported by further subargumentation). Indeed, the effects of unit size on ordering are numerous, and are often related to psychological restrictions on the tracking of focus - long premises (or supporting subarguments) may lead to a hearer forgetting how a premise contributes to previous or subsequent argumentation. Though occasionally acceptable (for example, when the 'apparent strategic goal' is modified [Gilbert 1996]), this usually leads to incoherency.

The two main forms of ordering (that occurring within the body of an operator, and that occurring between subarguments and their conclusion) show a number of interdependencies. For example, (A1) is an extract from an argument in the corpus[5] which complains about the abundance of 'tourist facility' signs which indicates pubs, restaurants, etc.

(A1) *Such signs add to roadside clutter and distract motorists by competing with essential information through being fixed on the supports holding road signs. The problem is aggravated when the signs have the colour and form of the traditional "temporary" AA*[6] *signs - which commanded attention for the information they carried.*

Although natural arguments can rarely be analysed unequivocally, the most plausible account for (A1) is shown in Figure 6. The conclusion of this fragment of the argument is *b*, that tourist facility signs distract motorists. This conclusion is supported by three subarguments, *a*, *c* and *g* (that the signs add to roadside clutter, compete with essential information, and command attention, respectively). The last two also have further supporting argumentation - *c* has *d* (that tourist facility signs are fixed on supports holding road signs), whilst *g* has the conjunction of *e* and *f* (that tourist facility signs resemble

[5] In a letter published in *The Guardian*, 19th October 1996
[6] Automobile Association

attention-commanding AA signs). Note that *g* is left implicit in the argument (indicated in the analysis by parentheses).

(*a*) ‘tourist facility’ signs add to roadside clutter
(*b*) t.f. signs distract motorists
(*c*) t.f. signs compete with essential information
(*d*) t.f. signs are fixed on the supports holding road signs
(*e*) t.f. signs have the colour and form of AA signs
(*f*) AA signs command attention
(*g*) t.f. signs command attention

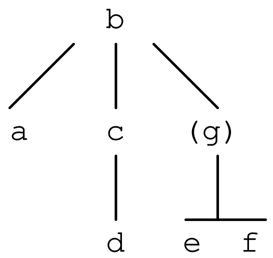


Figure 6. Analysis of (A1)

Clearly, a large number of orderings will be prohibited by the topic manipulators. Most of the examples offered by Cohen (1987) as examples of incoherency fall into this category - text (A2), for example, could not be generated within the framework of focus control:

(A2) *Such signs add to roadside clutter and have the colour and form of the traditional “temporary” AA signs. Motorists are distracted by the signs which compete with essential information. AA signs commanded attention for the information they carried. Tourist facility signs are fixed on the supports holding road signs.*

Although all the information is still there, the text is unintelligible due to the lack of any perceivable structure. However, even within the restrictions imposed by the topic manipulation operators, several orderings are necessary to render the text both coherent and effective.

Figure 7 shows how the planning process progresses. The initial goals are shown at stage (1). After a phase of planning, the complete abstract plan is as shown in stage (2). The components must then be ordered: at this stage, coherency constraints do not impinge upon the ordering at all; rather, the ordering is determined entirely on persuasive merit. So, for example, *a* lends weak support to the conclusion and so should go near the beginning and be followed closely by the conclusion; *g* lends strong support and may therefore be good to end with; etc. The result of this ordering is shown in (2a). The effect of such ordering can be quite significant - compare (A1) with (A3), for example, in which the same four components have been ordered differently. Although (A3) is coherent, it is noticeably less persuasive than (A1)

(A3) *Such signs have the colour and form of the traditional “temporary” AA signs - which commanded attention for the information they carried. They also compete with essential information through being fixed on the supports holding road signs. Lastly, they also add to roadside clutter, all helping to distract motorists.*

Figure 7, stage (3) shows the result of refinement, with the MP bodies opened up. The default ordering will suffice in every case except the last, which could easily confuse the hearer. The large subargument *c* (supported by *d*) intervenes between the conclusion and its last supporting subargument, so it is common to find explicit signalling of the relationship. This is often achieved by reversing the order of the premises of the final MP, placing the `MAKE_SALIENT (h, g ⊃ b, a)` ahead of `MAKE_SALIENT (h, g, b)`. The first of these two now establishes a link between the premise *g* and the conclusion *b*. At plan-time, when this reordering is effected, it is the components of the MP body which are rearranged. According to the restriction mentioned above, it is the `BEL/IS_SALIENT` pair which moves, as a discrete unit, as shown in stage (3a). This has the desired effect of placing the `MAKE_SALIENT (h, d ⊃ a, a)` step in the final plan earlier than both the `MAKE_SALIENT (h, d, a)` and the argumentation which supports it.

To demonstrate the importance of this reordering, it is omitted from text (A4) which attempts to convey the same information.

(A4) *Such signs add to roadside clutter and distract motorists by competing with essential information through being fixed on the supports holding road signs. The signs have the colour and form of the traditional “temporary” AA signs - which commanded attention for the information they carried, thus aggravating the problem..*

This version seems barely coherent, and although the judgement is ultimately a subjective one, even if it is granted that (A2) is coherent, it is clear that it is significantly *less* coherent than (A1). This remains the case regardless of the realised form of the `MAKE_SALIENT (h, d ⊃ a, a)`.

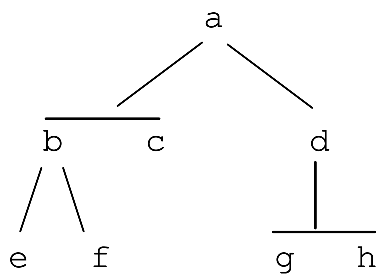
Figure 7 omits the subsequent stages of planning and refinement which include premises *e* and *f* and result in a plan of primitives such as that in Figure 5, as they do not involve further ordering.

The discussion above, based on the example (A1), only employs ordering between disjunctive premises (i.e. those which lend independent support to the conclusion). The ordering of conjunctive premises (i.e. groups of premises

```
(1)

BEL (h, b)
IS_SALIENT (h, b, _)

(2)                                  (2a)

MP (h, b)  X: a                      MP (h, b)  X: a
MP (h, b)  X: c                      MAKE_SALIENT (h, b, _)
MP (h, b)  X: g                      MP (h, b)  X: c
MAKE_SALIENT (h, b, _)               MP (h, b)  X: g

(3)                                  (3a)

PUSH_TOPIC (b)                       PUSH_TOPIC (b)
BEL (h, a)                           BEL (h, a)
IS_SALIENT (h, a, b)                 IS_SALIENT (h, a, b)
BEL (h, a⊃ b)                        BEL (h, a⊃ b)
IS_SALIENT (h, a⊃ b, b)              IS_SALIENT (h, a⊃ b, b)
POP_TOPIC (b)                        POP_TOPIC (b)

MAKE_SALIENT (h, b, _)               MAKE_SALIENT (h, b, _)

PUSH_TOPIC (b)                       PUSH_TOPIC (b)
BEL (h, c)                           BEL (h, c)
IS_SALIENT (h, c, b)                 IS_SALIENT (h, c, b)
BEL (h, c⊃ b)                        BEL (h, c⊃ b)
IS_SALIENT (h, c⊃ b, b)              IS_SALIENT (h, c⊃ b, b)
POP_TOPIC (b)                        POP_TOPIC (b)

PUSH_TOPIC (b)                       PUSH_TOPIC (b)
BEL (h, g)                           BEL (h, g⊃ b)
IS_SALIENT (h, g, b)                 IS_SALIENT (h, g⊃ b, b)
BEL (h, g⊃ b)                        BEL (h, g)
IS_SALIENT (h, g⊃ b, b)              IS_SALIENT (h, g, b)
POP_TOPIC (b)                        POP_TOPIC (b)
```

Figure 7: Reordering during (2) planning and (3) refinement

which must be taken together for the support to be valid) are handled in a similar way, through the use of the CONJ operator, which corresponds to the logical rule of inference of Conjunction, in the same way that the MP operator corresponds to Modus Ponens. The ordering process has access to a conjunction that supports a BEL goal, in the same way that it has access to MP or any of the other logical operators which might be used. And similarly, it does *not* have access to the contents of the body of those operators. Thus ordering can occur between disjuncts supporting a conclusion, but not between disjuncts and conjuncts. (Of course, the conjuncts can be ordered amongst themselves within the body of the CONJ). This is important because it ensures that a conclusion will not be interpositioned between two conjunctive supports (a situation which is almost always incoherent). An example showing the permitted scope of the ordering process at various levels of abstraction is given below in Figure 8.



The conclusion a is supported by the conjunction of the two premises b and c, and separately by d. The premise b is then supported indepedently by e and f; d is supported by the conjunction of g and h. There are a total of five orderings to be resolved:

Conclusion and two disjunct premises, (a, (b, c), d)

Two conjunct premises, (b, c)

Conclusion and two disjunct premises, (b, e, f)

Conclusion and one premise (d, (g, h))

Two conjunct premises (g, h)

Figure 8: Conjunctive and disjunctive orderings

Thus the ordering of conjunctive premises needs no new machinery, nor any explicit heuristics prohibiting their division: their handling is controlled solely through the use of the `CONJ` operator, which hides its body from the ordering at the superargument level.

The entire ordering framework therefore consists of just two scopings within in which a particular ordering must be determined at each level of abstraction: between the premises (i.e. the `BEL-IS_SALIENT` pairs) in an operator body, and between the conclusion and supports for that conclusion (i.e. the `IS_SALIENT` and the operators satisfying the `BEL` goal). This simplicity facilitates the identification and implementation of appropriate ordering heuristics.

5 Conclusion

This paper has shown how the architecture proposed in [Reed *et al.* 1996a] can be used to generate a number of focusing and ordering phenomena which have been identified in a corpus of arguments. It has been shown that adopting an approach to focusing wherein topic manipulation is carried out explicitly as part of an abstract plan, facilitates the generation of clue phrases, formatting and some punctuation. Lastly, the importance of componential ordering in argument has been discussed, and the main types of such ordering compared with features of the plan produced by the AS level, showing how the planning process can produce appropriate orderings. The impact that the various types of ordering have upon both coherency and persuasiveness of a corpus text has been demonstrated through consideration of comparable texts in which those orderings have not been made. Finally, it has been shown that the AS level, through consideration of focusing and coherency constraints is capable of producing all and only coherent orderings.

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