Deriving the Communicative Structure in Applied NLG

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Abstract

Information structure is decisive for constraining linguistic options during sentence planning. Nonetheless, it is only recently that it became a topic on the agenda of the mainstream text generation research. We investigate how certain parameters of the information (or communicative) structure developed in *Meaning-Text Linguistics* can be derived in applied text generation from the domain and discourse data, and how these parameters guide the process of sentence generation.

1 Introduction

One of the notorious problems NLG faces since its early days is the purposeful choice of one of the linguistic options available to express a given meaning. It is well known that a rich information structure constraints sentence structures, and thus, to a major extent, also the process of sentence generation (Prince, 1978; Vallduví, 1995; Choi, 1996; Mel'čuk, 2001). Existing proposals for the derivation of the information structure in the context of NLG draw mainly on contextual (extra-linguistic) information (Klabunde and Jansche, 1998; Geldorf, 2000) or on the communicative intent of the speaker (Stone et al., 2001; Creswell, 2002). Occasionally, recourse is made to semantic coherence relations (Creswell, 2002). We believe that a detailed information structure can be sufficiently determined only when the following sources are taken into account: (i) domain-specific communicative constraints (*domain communication knowledge* in (Rambow, 1990)), (ii) a detailed discourse structure as provided, e.g., by RST-based text planners, and (iii) the communicative intent of the speaker.

In what follows, we describe the derivation of the information structure in applied text generation from the above sources. As information structure, we use the *Communicative Structure* (henceforth CS) defined in the *Meaning-Text Theory* (MTT), which has the advantage of being detailed and rigorously defined; see (Mel'čuk, 2001). The derivation of the CS and its processing is currently being implemented in a text generator that is also based on MTT (Mel'čuk, 1988). The application domain under study is the ozone concentration domain in the province of Baden-Württemberg, Germany. Note, however, that the proposed approach is fully applicable to all data-oriented domains (such as stock market, flood surveyance, weather forecast, etc.).

2 Communicative Structure in MTT

Hardly any other notion in linguistics received such a heterogeneous presentation across the different theories as the information (= communicative) structure. But it cannot be our goal to present here a constrastive overview of the different interpretations. Rather, we concentrate on a brief presentation of MTT's CS as described in (Mel'čuk, 2001).

MTT's CS is defined on a semantic structure S_{sem} and consists of eight different *dimensions* or *tuples of contrastive information parameters*. Six of them call for consideration in NLG:[1]

1. Thematicity (*Rheme* vs. *Theme*),
2. Giveness (*Given* vs. *New*),
3. Focalization (*Focalized* vs. *Non-Focalized*),
4. Perspective (*Foregrounded* vs. *Backgrounded*),
5. Presupposedness (*Presupposed* vs. *Asserted*),
6. Unitariness (*Unitary* vs. *Articulated*).

[1]The seventh, *Emphasis* is immediately relevant to speech generation, and the eighth, *Locutionality* to combined gesture-language generation.

In what follows, we restrict their introduction to short definitions and a minimal number of examples; the interested reader is asked to consult (Mel'čuk, 2001). Note also that the definitions reflect the generative point of view, not the analytical one. Therefore, they do not define the parameters in terms of surface clues to be used to identify the former in a sentence, but, rather, in terms of the intentions of the Speaker.

Rheme vs. Theme. *Rheme* is that part of S_{sem} that the Speaker intends to present as being communicated. *Theme* is that part of S_{sem} that the Speaker intends to present as something about which Rheme is stated. (Theme is also sometimes referred to as *topic*, *starting point*, or *old*; Rheme—as *comment*, *focus*, and *new*.)

Depending on its POS and the interrelation with other parameters, a thematized element may be realized as the Subject of a clause, be fronted or be proleptized. The Rheme/Theme-dimension constraints thus lexicalization, syntactic choice and word order. Cf. an example:

1. *The typical function of an interrogative clause* $_{Th}$ *is to ask a question* $_{Rh}$
2. *In a wh-interrogative,* *the Theme* $_{Th}$ *consists of the wh-element.* $_{Rh}$

Given vs. New. *Given* is the part of S_{sem} that the Speaker intends to present as being in the Addressee's current consciousness or easily accessible by the Addressee. *New* is that part of S_{sem} that the Speaker intends to present as being new to the Addressee.

Since most often the Speaker assumes that the information being stated is new to the Addressee, while the information about which it is stated is present in the Addressee's consciousness, Rheme/Theme and Given/New are often conflated (this is why Theme/Rheme is sometimes called *old/new*; see above). However, it does not need to be the case that they coincide; consider, e.g.:

A farmer from Sommerset $_{Th/New}$
has found a Roman chamberpot $_{Rh/New}$.

Given elements are usually expressed by anaphora. As suggested by Gundel (1988), MTT distinguishes four degrees of giveness: (1) unique identifiability, (2) familiarity, (3) activatedness, and (4) focality. Each of the degrees licenses primarily the choice of specific anaphoric references: (1) of the definite article, (2) of the deictic THAT, (3) of the deictic THIS, and (4) of a personal pronoun (HE, SHE, ...). That is, the Given/New dimension constraints primarily morphosyntactic options, but also lexical and syntactic ones. Cf. (from Halliday, 1994):

1. *There was* *a little guinea pig,* $_{New}$
2. *which,* $_{Given}$ *being little,* $_{Given}$, *was not big.* $_{New}$

Focalized vs. Non-Focalized. *Focalized* is that part of S_{sem} that the Speaker intends to present as being focus of attention, i.e., logically prominent for him.

Focalization presents a configuration of entities as excluding other logical options: "exactly X, and not something else". The linguistic means to express focalization (or *focus*) include first of all *dislocation* or *detachment* and various types of *cleft-ing*; cf.:

1. *To* *my daughter* $_{Foc}$ *the uncle sent a doll, to his son he sent a toy car.*
2. *It was* *the uncle* $_{Foc}$ *who sent my daughter that doll*

Foregrounded vs. Backgrounded. *Foregrounded* is that part of S_{sem} that the Speaker intends to present as being psychologically prominent for him. *Backgrounded* is that part of S_{sem} that the Speaker intends to present as being psychologicall secondary for him. Some parts of S_{sem} may be neither foregrounded nor backgrounded.

The main linguistic means for the realization of foregrounded elements is raising; for the realization of backgrounded elements—parenthetical constructions and downing; cf. (from the web):

1. *I changed my girl's oil yesterday and washed the car for* *her* $_{Foregr}$ (in contrast to *... and washed her car*, which is neutral)
2. *The prisoner* *(who was a skillful climber)* $_{Backgr}$ *climbed over the fence and escaped.*

Presupposed vs. Asserted. Mel'čuk (2001) distinguishes between two types of presupposition: "pragmatic" presupposition and "linguistic" presupposition, focusing on the latter one.

Linguistically presupposed is that part of S_{sem} that the Speaker intends to present as taken for

granted. (If the whole structure is negated or questioned, the presupposed fragment remained affirmed.) The part that is not presupposed is *Asserted.*

Linguistically presupposed elements can be realized only as attributive (modifying or appositive) constructions; cf.:

1. *The car,* *which was an old Renault* $_{Pres}$, *broke down soon after we left the town.*
2. Germ. *Bei Ute* $_{Pres}$ *liegt ein Toter* *unterm Sofa* $_{Pres}$ lit. 'At Ute's, lies a dead man under the couch'. vs. *Unter Utes Sofa liegt ein Toter* 'Under Ute's couch lies a dead man'.[2]

In German, Presupposedness also constraints word order (see below).

"Pragmatic" presupposition as used in generation, e.g., in (Stone et al., 2001), encloses all elements that are expected to be familiar to the reader (either from his world knowledge, from the context, or from the text). For generation, both types of presupposition are needed.

Unitary vs. Articulated. *Unitary* is the part of S_{sem} that the Speaker intends to present as being looked at as one (opaque) single entity. *Articulated* is the part of S_{sem} which the Speaker intends to present as being a configuration of semantic entities.

Fragments of S_{sem} that are marked as Unitary are preferably expressed by single lexemes; those that are marked as Articulated, are preferrably expressed such that each element in the semantic structure receives an own lexical item; cf.:

1. *The* *compiler* $_{Unitary}$ *is very efficient.*
2. *The program for compiling user written code* $_{Artic.}$ *is very efficient.*

The unitary/articulated dimension is especially important in German where regular compound production allows for a unitary realization of a broad range of configurations of semantic units.

3 The Starting Point

In this section, we introduce the resources that serve us as a basis for the derivation of the above communicative dimensions, i.e., that we presuppose as being available.[3]

[2]Only the first variant implies (presupposes) that Ute's couch is indeed at Ute's.

[3]This is not to say, of course, that we do not deal with them at all. Rather, their processing is not our topic here.

3.1 Data and Discourse Structure

We presuppose that an applied text generator starts from data stored, e.g., in a data base. In our application, these data are measuring data that are exported from a DB into an XML-document.

An "expert system" module evaluates these data, compiles a set of communicative goals that are to be achieved, and chooses the data that are relevant to these goals.

From the communicative goals, a text plan with RST-like discourse relations (Mann and Thompson, 1987) is derived. Besides RST-relations, we use Halliday's (1994) *expansion relations* ENHANCEMENT and EXTENSION and their more fine-grained variants. Our use of discourse relations differs from the use in traditional RST in two respects:

(i) specifying a discourse relation between the discourse units DU_1 and DU_2, we also specify which elements in DU_1 and DU_2 are involved in the relation; thus, the CONTRAST-relation between (a) and (b) in

(a) *It was John who sent my daughter the doll.* (b) *Mary never sends her anything*

the "hubs" of the nuclei are *John* and *Mary*, respectively (not, e.g., *doll* and *nothing*).

(ii) several relations may hold between DU_1 and DU_2 (see also (Moore and Pollack, 1992) on the need for multi-level analysis of RST-relations).

As mentioned above, we presuppose that a text plan has already been compiled when we start the compilation of the CS.

3.2 Domain Communication Data

Originally defined for the semantic level, MTT's communicative dimensions can also be used at the conceptual, i.e. "prelinguistic", level. For some of them, initial settings are already available before generation starts. They are predetermined by the domain, by the design of the interface via which the reader communicates with the generator, and by the actions the user takes during the session.

Data on Thematicity In applied generation, the global theme of the discourse (i.e., the discourse topic) is either known—if the generator is specialized on one text type—, or the reader determines it by choosing a specific topic via the generator interface. The theme and rheme of the first message in

the text are either directly related to the discourse theme or can be derived from actions of the reader.

In our application, the discourse theme is determined by the goal-directed action of going to the web page of the generator: *Ozone in the province of Baden-Württemberg, Germany*. The initial discourse theme is thus 'ozone'. The page contains a map of Baden-Württemberg with stations that measure ozone being marked by a dot. By clicking onto a station on the map, the user determines the name of the station as the secondary theme. The information on the current concentration at the station in question constitutes the corresponding secondary rheme.

Note that on his first visit to the page, the reader has no explicit information that the texts will be about ozone CONCENTRATION. Therefore, discourse theme is 'ozone' only. After the first text has been generated, the discourse theme is extended to 'ozone concentration' for all subsequent messages.

Data on Giveness Some of the information units can be considered as given to (or known by) the reader before any text is generated or even planned; some others as unknown or new. Cf. Table 1 for the distribution of the given/new-parameter in our domain for the most important data:

Table 1: Giveness of entities

Entity	given	new
substance (ozone)	x	
values (concentrations)		x
measuring unit ($\mu g/m^3$)	x	
times (measured at)		x
locations (measuring stations)	x	
names of applicable thresholds	x	
values of applicable thresholds		x

Data on Focalization An entity e is a candidate for focalization, e.g., if:

- a specific (prominent) property or event can be assigned to several entities, and it is assigned to e,
- e belongs to the global discourse rheme or to a preceding local initial rheme.

Due to these conditions, in our domain, e.g., current ozone concentration ($O_3^{t_{curr}}$) can be focalized if it is either the highest or the lowest concentration in the region; also, t_{ref} (= the time whose concentration is contrasted to the current concentration). Air quality experts suggest that it is not adequate to focalize any information in the first message of the text.

Data on Perspective In an informative discourse, data that are in one way or the other unusual or are supposed to somehow influence the reader can be foregrounded, i.e., "marked as being psychologically primary". Data or their evaluation that are "normal" from the perspective of the reader may be backgrounded, i.e., "marked as psychologically secondary". Backgrounded may be also data that are the premise of an evaluation of data that is foregrounded (as, e.g., in *Um 18 Uhr hat die Ozonkonzentration in Stuttgart mit 217 $\mu g/m^3$ den höchsten Wert des Tages erreicht* the *mit*-Konstruktion backgrounds the actual concentration).

In our domain, sentence constructions with foregrounded elements have been judged "too dramatic". Consider (b) in the following example:
(a) *An der Messstation Esslingen wurde um 18 Uhr eine Ozonkonzentration von 217 $\mu g/m^3$ gemessen* 'At the measuring station Esslingen, at 18 o'clock, an ozone concentration of 217 $\mu g/m^3$ has been measured' ... (b) *Diese Konzentration war zu der Zeit in der Region Mittlerer Neckar der Höchstwert* 'This concentration was at this time the highest-value in the region Mittlerer Neckar.'

The modifier *höchste* in *höchste Konzentration* is raised to the sentential complement to build the compound *Höchstwert* and thus focalized (recall that the main syntactic means to realize foregrounded elements is raising). A more appropriate variant contains no foregrounded elements; cf.:
(a) ... (b) *Dieser Wert war die höchste zu dieser Zeit in der Region Mittlerer Neckar gemessene Konzentration.* 'This value was the highest concentration measured at this time in the region Mittlerer Neckar'.

Therefore, we use the 'background' parameter only.

Data on Presupposedness Certain elements of the discourse that are very prominent in the reader's mind can and should be omitted—either from the start or after their first mention. That is, they are pragmatically presupposed. In our domain, this is the name of the measuring station for which the reader asked for information.

In our domain, we can further identify some linguistically presupposed elements before generation starts: with the user's action of clicking on a measuring station, we can presuppose (i) the concept of 'ozone concentration', the location (i.e. measuring station), and the time at which the measure has taken place. The ozone concentration is asserted.

Note that the presuposedness of time prevents the shift of the time circumstantial to the final position in the clause (which is *per se* allowed in German):[4]

#*An der Messstation Heilbronn lag die Ozonkonzentration bei 182 $\mu g/m^3$ um 18 Uhr* lit. 'At the measuring station Heilbronn, the ozone concentration was at 182 $\mu g/m^3$ at 18 o'clock'.

Data on Unitariness. Often, a domain prescribes a unitary or an articulated realization of specific information elements. Thus, articles on a computer science issue written for professionals would hardly use *program for compiling user written code* to refer to a compiler, while in a paper for laymen, it would make sense to introduce the term "compiler" by an articulated lexicalization of the concept.

In our domain, the following information units are unitary by definition: (1) location + name, (2) time + time instance, (3) substance + 'concentration'.

4 Deriving the Communicative Structure

With the initial domain data, domain communication data, and the text plan at hand, the instantiation of the communicative dimensions can be derived for each message to be generated. In this section, we illustrate how the parameters for the first four dimensions from above can be dynamically determined by a set of communicative rules. The parameters of the other two dimensions are determined analogously.

To facilitate the presentation, let us first introduce some notations and conventions: (1) $\mathcal{M}$ stands for 'message under construction', and $\mathcal{M}^-$, for 'one of the preceding messages' (an index may be additionally given if more than one of the preceding messages is considered). (2) $DU_{\mathcal{M}^-}$ and $DU_{\mathcal{M}}$ stand for 'discourse unit containing message $\mathcal{M}^-$ or $\mathcal{M}$, respectively'. (3) Pairs of the type 'ozone concentration–Y $\mu g/m^3$', 'age–4 months', 'time–5pm', etc. will be referred to as 'token–value' (t–v).

Theme/Rheme. To determine Theme and Rheme of the message in question, we draw upon all of the above types of data. Consider examples for the use of each. The use of the domain communication data is most obvious:

If $\mathcal{M}$ is the first to be generated then

$Th_{\mathcal{M}} := Th_{discourse} \cup Th_{init,secondary}$
$Rh_{\mathcal{M}} := Rh_{init,secondary}$

Discourse relations are often decisive when the thematic structure of one of the subsequent messages is determined. Consider:

(a) *An der Station Stuttgart wurden um 18 Uhr 180 $\mu g/m^3$ Ozon gemessen* 'At the station Stuttgart at 18 o'clock, 180 $\mu g/m^3$ have been measured'. (b) *Um 17 Uhr lag der Wert noch bei 120 $\mu g/m^3$* 'At 17 o'clock, the value still was at 120 $\mu g/m^3$'.

(a) *Sven Hannawald sprang in Bischofshofen 132.5m weit* lit. 'Sven Hannawald jumped in Bischofshofen 132.5m far.' (b) *In Garmisch waren es nur noch 124m.* lit. 'In Garmisch, they were only just 124m'.

In both examples, between (a) and (b) a CONTRAST relation holds; more precisely, between the values of a token (in the first, the token is 'ozone concentration', in the second, 'length') with respect to a circumstantial ('time' in the first and 'location' in the second). In both (a)s, the token belongs to Theme and value and the circumstantial to Rheme. In both (b)s, the token and the circumstantial are Theme, and the value is Rheme. This is a regular pattern. We can thus formulate the following rule:

If between $DU_{\mathcal{M}^-}$ and $DU_{\mathcal{M}}$ a CONTRAST-relation holds and
1. it contrasts the values $v^- \in \mathcal{M}^-$ and $v \in \mathcal{M}$ of the token t with respect to the circumstantial c,
2. $t \in Th_{\mathcal{M}^-}$, $v^- \in Rh_{\mathcal{M}^-}$, $c \in Rh_{\mathcal{M}^-}$
Then, $Th_{\mathcal{M}} \leftarrow t$; $Th_{\mathcal{M}} \leftarrow c$; $Rh_{\mathcal{M}} \leftarrow v$

Consider now

(a) *Die Ozonkonzentration lag um 18 Uhr bei 198 $\mu g/m^3$* 'The ozone concentration was at 18h at 198 $\mu g/m^3$'. (b) *Das war der höchste Wert in der Region Mittlerer Neckar* 'This was the highest value in the region Mittlerer Neckar'.

(a) *Sven Hannawald sprang in Bischofshofen 132.5m weit* lit. 'Sven Hannawald jumped in Bischofshofen 132.5m far.'

[4] '#' marks communicatively inadequate utterances.

(b) *Das war der weiteste Sprung des Tages* 'This was the longest jump of the day'.

Between the (a) and (b) the EVALUATION relation holds. Again, we can detect a stable theme pattern: the value of a token introduced, i.e. rhematized, in (a), is evaluated in (b) and is thus part of theme in (b). Cf. the corresponding rule:

If between $DU_{\mathcal{M}^-}$ and $DU_{\mathcal{M}}$ an EVALUATION-relation holds and
1. the value $v^- \in \mathcal{M}^-$ of a token $t \in \mathcal{M}^-$ is evaluated by the entity e in $\mathcal{M}$,
2. $t \in Th_{\mathcal{M}^-}$ and $v^- \in Rh_{\mathcal{M}^-}$
Then, $Th_{\mathcal{M}} \leftarrow v^{-1}$; $Rh_{\mathcal{M}} \leftarrow e$.

Other relations, such as ELABORATION, ENHANCEMENT, and JUSTIFICATION are equally used for the derivation of thematic patterns.

The use of factual domain data along with discourse relations can be illustrated by the following example:

(a) *217 $\mu g/m^3$ ist relativ viel* lit. '217 $\mu g/m^3$ is relatively much', (b) *wenn auch der Alarmschwellenwert von 240 $\mu g/m^3$ noch nicht erreicht ist* 'although the alarm threshold of 240 $\mu g/m^3$ has not yet been reached'.

Here, between (a) and (b) a CONCESSION relation holds. In (a), *217 $\mu g/m^3$* is the Theme, in (b) *der Alarmschwellenwert von 240 $\mu g/m^3$*. That is, we have the general pattern 'X is Y, but not yet Z'. This pattern is captured by the following rule:

If between $DU_{\mathcal{M}^-}$ and $DU_{\mathcal{M}}$ a CONCESSION-relation holds and
1. $\mathcal{M}^-$ contains an attribute assignment 'v^- IS a',
2. $\mathcal{M}$ is a statement that $v^- <$ threshold τ,
3. $v^- \in Th_{\mathcal{M}}$ and $v^- >$ threshold α
Then, $Th_{\mathcal{M}} \leftarrow \tau$; $Rh_{\mathcal{M}} \leftarrow \tau > v^-$

Given/New. The task of the Given/New-rules is on the one hand to change the giveness status of entities that have been mentioned in the current message for the first time from 'New' to 'Given' and, on the other hand, to assign a giveness degree to 'Given' entities.

To all entities that are marked as 'Given' in the initial given/new-table, we assign the giveness degree 1.

The degree of giveness of an entity with respect to $\mathcal{M}$ (i.e. the message planned) depends on the distance of this entity from $\mathcal{M}$ (measured in number of words or messages). This is well-known from the approaches to the generation of referring expressions (Dale and Reiter, 1995; Horacek, 1995). Which degree is assigned to the entities immediately at $\mathcal{M}$ and how quickly (or whether) the degree is decremented with the increasing distance depends on the domain and on the nature of each individual entity. In our domain, only two degrees are used: 1 and 4. The concept 'ozone concentration' is assigned the degree 4 at the point of its mention; at message distance 2, the degree is set to 1. All other given entities receive a constant degree 1.

Degree 4 licenses the use of a personal pronoun and the deictic pronoun DIESE(R) 'this', and degree 1 licenses the use of the definite article.

Focalized. Criteria for focalization tend to be more idiosyncratic than the criteria for thematization. Nonetheless, since focalization usually happens in context, focalization rules draw on both discourse relations and ideational domain data.

A typical focalization is illustrated by the following discourses:

(a) An der Messstation Heilbronn wurden heute 86 $\mu g/m^3$ gemessen lit. 'At the measuring station Heilbronn, today 86 $\mu g/m^3$ have been measured' ...(b) *86 $\mu g/m^3$, das war der niedrigste Wert der Region Mittlerer Neckar* '86 $\mu g/m^3$, this was the lowest value of the Mittlerer Neckar region'.

(a) *Hannawald sprang heute 132m* 'Hannawald jumped today 132m' ...(b) *132m, das war der längste Sprung des Tages* '132m, this was the longest jump of the day'.

Between (a) and (b), which appear in the discourse at a certain distance from each other, an EVALUATION-relation holds: (b) evaluates (a)'s rheme v^-. The evaluation in (b) consists of the statement 'v^- is highest/lowest in the given range'. The following rule captures this pattern:

If between $DU_{\mathcal{M}^-}$ and $DU_{\mathcal{M}}$ an EVALUATION-relation holds and
1. the value $v^- \in \mathcal{M}^-$ of a token $t \in \mathcal{M}^-$ is evaluated by the entity e in $\mathcal{M}$,
2. $v^- \in Rh_{\mathcal{M}^-}$;
3. e states that v^- is the highest/lowest in a given range
Then, $Focus_{\mathcal{M}} \leftarrow v^-$.

Similar rules can be defined for such cases as illustrated by the following examples (focalized entities are underlined):

(a) *An der Messstation Heilbronn wurden um 17 Uhr 47 $\mu g/m^3$ gemessen* 'At the measuring station Heilbronn, at 17 o'clock, 47 $\mu g/m^3$ have been measured'. (b) *Gegenüber 16 Uhr, als der Wert bei 20 $\mu g/m^3$ lag, hat sich also die*

Konzentration mehr als verdoppelt. lit. 'Compared to 16 o'clock, when the value was about 20 $\mu g/m^3$, the concentration thus more than doubled'.
where a CONTRAST relation holds between (a) and (b).

(a) ...(b) *Was die anderen Messstationen der Region Mittlerer Neckar betrifft, so lagen dort die Werte zwischen 51 $\mu g/m^3$ in Esslingen und 67 $\mu g/m^3$ in Plochingen* 'As far as the other stations in the region Mittlerer Neckar are concerned, the values there were between 51 $\mu g/m^3$ in Esslingen and 67 $\mu g/m^3$ in Plochingen',
where an ENHANCEMENT-relation holds between (a) and (b).

Backgrounded. As mentioned above, in accordance with the characteristics of our domain, we do not mark any information as 'Foregrounded'. We background only in the case of the following pattern:

If between $DU_{\mathcal{M}^-}$ and $DU_{\mathcal{M}}$ an EVALUATION-relation holds and
1. the value $v^- \in \mathcal{M}^-$ of a token $t \in \mathcal{M}^-$ is evaluated by the entity e in $\mathcal{M}$,
2. v^- is unusually high,
3. $v^- \in Rh_{\mathcal{M}^-}$,
4. e states that v^- is the highest in a given range
Then $Background_{\mathcal{M}^-} \leftarrow v^-$.

(compare the similarity with the focalization pattern above).

The backgrounded element is "downed" such that $\mathcal{M}^-$ and $\mathcal{M}$ are realized in one clause; cf.:
An der Messstation Heilbronn wurde um 18 Uhr mit 198 $\mu g/m^3$ der höchste Wert des Tages erreicht lit. 'At the measuring station Heilbronn, at 18 o'clock with 198 $\mu g/m^3$ the highest value of the day has been reached.
(*198 $\mu g/m^3$* is downed by the use of a *mit* 'with'-PP).

5 Processing Comm. Structure

MTT is a multistratal theory. The most abstract stratum (or level) we use is the conceptual stratum; the most concrete stratum that is relevant for generation is the surface-morphological level, which can be considered as a chain of inflected wordforms. The representations at each level can, somewhat simplified, be assumed as consisting of two structures: the basic (propositional) structure and the CS, which is defined on the basic structure and thus partitions the basic structure in terms of communicative dimensions.

Generation in the sense of MTT consists of a series of mappings between representations of adjacent levels, starting from the conceptual representation that is annotated with communicative dimensions and going up until the surface-morphological representation is reached; for an implementation, see (Bohnet and Wanner, 2001).

In Section 2, we have already indicated the linguistic means by which the individual communicative parameters are realized. During the transition from level E_i to level E_{i+1}, a communicative parameter is either realized by the appropriate linguistic means available at E_{i+1} or is mapped onto the CS of E_{i+1}, i.e., propagated to E_{i+1} in order to be realized on one of the higher levels. Both the realization and the propagation are specified in terms of communicative rules, which make part of the grammar rules. The communicative rules are discussed at length in a longer version of this paper.

6 Related Work

Among the first to apply the information structure to text generation were C. Matthiessen (1985), K. McKeown (1985), and L. Iordanskaja (1992). Especially Iordanskaja discusses in detail how Thematization influences the order of the messages in a text plan, and, to a certain extent, also aggregation.

More recently, Humphreys (1995) investigated how the speaker's (communicative) intentions guide the choice of such "non-canonical" sentence patterns in English as clefting and dislocation (which we considered as realizations of *focalized* elements). As Humphreys, Stone *et al.* (2001) relate in the SPUD-system sentence planning options to communicative intentions of the speaker, which are in their case captured by *Assertion*, *Presupposition* and *Pragmatics* (while Humphreys develops explicit speaker and hearer models). Note that Assertion and Presupposition in SPUD are "pragmatic notions" (see Section 2). Creswell (2002) extends Stone *et al.*'s approach by three types of more fine-grained communicative goals: attention marking, discourse relation, and focus disambiguation. As examples of discourse relations Creswell cites NARRATIVE and PARALLEL. However, it is not clear how many and which discourse

relations are covered. But, obviously, Creswell's proposal is similar to ours.

7 Summary and Future Work

We presented how discourse structure relations and domain communication data can be used to compile a CS, which guides then sentence planning and realization. The described model is an extension of the model underlying the *AutoText UIS* generator, which has been developed in cooperation with the Ministry of Environment and Traffic, Baden-Württemberg (Bohnet and *et al.*, 2001) and which is in action since summer 2001. The extended model is currently under implementation. However, it still reveals several limitations. Thus, we work so far with a subset of RST-like relations in the air quality domain restricted to ozone. It is planned to extend the generation to other substances in this domain—which implies a broader coverage of discourse relations, and thus, also a broader coverage of the interrelation between discourse relations and communicative dimensions. However, the air quality domain alone is certainly still too restricted for a full scale coverage of the phenomena related to CS. Therefore, we plan to examine two other application domains: flood surveyance and weather forecast. In parallel, we continue to work on the extension of our sentence grammar module.

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