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On the descriptive adequacy of topology

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Abstract
This article attempts to sum up the history of the topological structure in MTT and to analyze its prospects in the future development of the theory. We discuss the raison d'être for considering the existence of the topological constituent tree as well as the constraints on its form. We discuss in particular the necessary information for the computation of the topology-phonology interface.

1. Linearization with and without topology

The history of topology can be traced back to the 19th century descriptions of German sentence structure, where this notion is particularly useful for the modeling of the German(ic) V2 constraint (i.e. exactly one constituent of any function before the finite verb) (Erdmann 1886, Drach 1937). The basic quite trivial idea is to suppose the existence of templates (domains) of places (often called "fields"), which exist independently of a particular syntactic function and can be filled based both on syntactic and communicative rules. This allows a straightforward description of the V2 phenomenon and any learner of German hears somehow about the existence of these fields. In a sense, the topological description can be seen as a first step in the separation of syntax and word order constitutive to dependency approaches ever since Tesnière 1959.

1.1. Alternatives to topology

It is clear that GB based descriptions have great difficulties controlling the unique element before the verb (cf. the discussion on IP vs. CP occupation of the finite verb). Similarly, dependency linearization rules based exclusively on precedence rules among governors and its dependents (or among dependents of the same governor), as it was commonly proposed and implemented (Mel'čuk & Pertsov 1987, Nasr 1995, Kahane 2001), have the exact same expressive power as context free grammars and can thus never handle any long distance phenomena in a satisfying manner (Gerdes & Kahane to appear).

Mel'čuk's model (1988) has already a hierarchical constituent structure on the morphological level, the prosodic markup, very similar to the resulting topological structure.[1] However no details concerning this prosodic markup are put forward, let alone precise criteria of what it should contain and how it is computed from the syntactic representation.

In order to be understood beyond the borders of MTT, "topology" is a more adequate name than "morphology" for the (linearized) level following the dependency representation because the structure and the rules handle interword relations and not only intraword structures. (With the habitual meaning of "morphology", it is odd to consider prosodic word groups on a "morphological" level.)

classical MTT (Mel'čuk 1988)	**model (following Gerdes & Kahane 2001 and Yoo 2003)**
Surface syntax	Surface syntax
Deep morphology (with prosodic grouping and contours)	Morpho-topology (constituent tree and morphological structure: leaves are morphemes)
Surface morphology	Phonology (prosodic grouping and contours)
Deep phonology	Phonetics
Surface phonology (text)	Sound

1.2. Why topology is useful for linearization

It has been shown on numerous occasions that topological linearization grammars can handle very difficult word order constraints in an elegant and simple manner:

[1] More precisely, in Mel'čuk 1988, the prosodic markup consists of a set of delimiters in various levels. This leveling induces a hierarchy of constituents (constituents with level 1 delimiters are included in constituents with level 2 delimiters and so on).

- V2, verb clusters and verbal pied piping of German (Debusmann & Duchier 2001, Gerdes & Kahane 2001)
- final verb cluster of Korean (Gerdes & Yoo 2004)
- extraction constraints from phrasal complements in Modern Greek (Yoo 2003b)
- long distance subject inversion and clitic climbing in French (Gerdes & Kahane 2004)
- dislocation from nominal phrases of Arabic (El Kassad & Kahane 2004).

The topological approach has also proven to be a useful simplification for the order rules of other formal frameworks as HPSG (Kathol 1995) and LFG (Clément *et al.* 2002, Frank 2003)

We consider that the existence of a hierarchical constituent structure in the linearization process of a dependency tree is incontestable. The question that remains to be discussed is the following: Is a topological tree just the technical result of the linearization process or is it a linguistically motivated independent structure? If it is an independent structure, what should it represent?

We will proceed by developing two points: The explanatory power of the topological structure for certain word order constraints. This will be done by showing how different order constraints combine to form the topological structure. Secondly, we will show that the topological structure is necessary for the computation of the phonological structure (with its prosodic groupings).

2. The topological structure

When describing word order topologically, we state the linear order of the fields composing a domain (see Mel'čuk 1967 for a similar idea). As the same domains can occur recursively in embedded sentences, it is somehow natural, though rarely explicitly stated, that we obtain a hierarchy of domains. The resulting structure, called a topological structure (Gerdes & Kahane 2001), is an ordered constituent structure, a fact that scares away hard core dependency advocates. It is important to understand though that the topological structure is not a syntactic structure for it does not express any syntactic function of any of its arguments, contrarily to X-bar approaches where the same structure jumbles functional information and constituent structure.

The original formalization by Gerdes & Kahane 2001 does not include communicative information in the linearization grammar, resulting in a quite high number of possible word orders for a given dependency tree. For even "freer" word order language like Russian and Modern Greek ("free" in the sense that order depends only little on the category or the syntactic function of the words), a grammar that does not take into account communicative information overgenerates massively. Yoo 2003b has extended the formalization to include into the linearization grammar a simple cutting up of the dependency tree in communicative zones, a simplification of the communicative zones of Mel'cuk 2001. Such a grammar is called a "communicative topological grammar". This grammar results in domains (sequences of fields) that put together into one structure these two quite independent constraints. The status of the resulting topological structure is not clear cut. In Greek, for example, you can have fields for complementizing elements (morpho-syntactic constraint) next to fields reserved for prominent theme elements (communicative constraint).

2.1. German

A communicative linearization grammar for German (see Gerdes 2002) has to include the usual topic-focus-tail division (see Büring 1997, Vallduvi 1992) in addition to the syntactic constraints (e.g. V2: finite verb of declarative sentences in second position). Instead of the famous unique *main domain* (*Vorfeld, left bracket, Mittelfeld, right bracket, Nachfeld*)[2], the separation between the communicative units can fall anywhere in the main domain, in particular into the Mittelfeld, which brings upon a list of different main domains having the Mittelfeld being cut off differently between the communicative parts. In such a description, it might seem as if we lost the intuitive (and classical) character of the topological description and we ended up in a two step process of explanation: We have different order constraints (the five fields from the syntactic constraints and three independent fields from the communicative constraints) and these constraints are subsequently overlaid to produce a certain number of combined domains. Only the latter are used in the actual topological grammar.

[2] *Vorfeld* ('prefield'), *Mittelfeld* (middlefield), and *Nachfeld* (postfield) are the classical German terms in the topological description.

Simple communicative constraints for German:

[Theme (prominent, or "topic" (T)) < Rheme (or "Focus" (F)) < Theme (non prominent, or "tail" (t))]

We can add the common operators from regular expressions to the fields in order to express the fact that we need exactly one focus element and an arbitrary number of theme and tail elements: [T* F! t*].

Syntactic constraints for German:

[Vorfeld (vf)! < left bracket (lb)! < Mittelfeld (mf) < right bracket (rb)? < Nachfeld (nf)*]*

The left bracket accepts the finite verb or the complementizer, the right bracket hosts the verb cluster.

When superposing the communicative and the syntactic constraints, we end up with different combined main domains that allow various orders depending on the communicative division of the sentence. In the context of (Q1) for example, the focal part will have to end up completely in the Mittelfeld of the combined resulting main domain shown below (which will be excluded if the finite verb is part of the focus, because the finite verb has to rejoin the left bracket – see second example below).

syntactic constraints:	vf	lb	mf			rb	nf
communicative constraints:	T			F	t		
one possible resulting domain :	vf-T	lb-T	mf-T	mf-F	mf-t	rb-t	nf-t

(Q1) Wann hat Peter die Erdebeeren den Goldfischen gefüttert?
When did Peter feed the goldfish with strawberries?

	vf-T	lb-T	mf-T	mf-F	mf-t	rb-t	nf-t
(A1)	Peter	hat	die Erdbeeren	schon gestern	den Goldfischen	gefüttert.	

Peter (nom.) has the strawberries (acc.) already yesterday the goldfish (dat.) fed?
Peter fed the goldfish with strawberries yesterday already.

Another combination for a different communicative division without topical part (possible since the topic is not obligatory):

syntactic constraints:		vf	lb	mf	rb	nf
communicative constraints:	T	F				t
another possible resulting domain:		vf-F	lb-F	mf-F	rb-F	nf-t

(Q2) Und essen Goldfische denn eigentlich Erdbeeren?
And do goldfish really eat strawberries?

	vf-F	lb-F	mf-F	rb-F	nf-t
(A2)	Ich	war	lange davon	überzeugt,	dass Goldfische Erdbeeren essen.

I (nom.) was for_long of_that convinced that goldfish (nom.) strawberries (acc.) eat.
I was convinced for long that goldfish eat strawberries.

All syntactic fields can superpose any communicative field, the only constraint being the existence of a focal part. This implies that tail and Vorfeld are incompatible.
We see how the two easy order constraints (syntactic and communicative) combine to form the quite complex main domains for German.

2.2 French

Let us turn to a similar phenomenon in French. Contrarily to German, it seems that the communicative structure has only a little role to play in French. The verbal domain is rich and contains numerous fields in order to insure the correct placement of clitics (fields having the *X-cl* tag) as well as the possibility of left or right dislocation (the *prefix* and *postfix* fields). The *Vorfeld* is, as in German, open to a unique element, usually the subject, whereas the *Mittelfeld* receives any number of complements. The *comp* field receives the possible complementizer. The finite verb is placed in the *verb* field whereas any bare predicative element (participle, infinitive, predicative noun or adjective) possibly separated by an adverb from its head go to the *pred* field.

Thus, the syntax of the finite verb in French consists of the following template of fields which accommodate the verb's syntactic dependents:

verbal domain: *comp < prefix < Vorfeld < neg-cl < me-cl < acc-cl < dat-cl < y-cl < en-cl < verb < subj-encl < adv < pred < Mittelfeld < postfix*

Just like in German, this "flat" structure results from the overlaying of a second set of linear constraints whose linguistic motivation is more easily accessible and which shows that French is actually quite similar to German. This second set of linear constraints organizes the verbal domain in four templates embedded one into the other: macro-domain, kernel, cluster, and chunk.

The (verbal) **chunk** presents a very rigid order and does not allow any inset clause. It receives the verb and the clitics and must form a prosodic word. The **cluster** contains the chunk: It can carry other light elements (we use the term introduced by Abeillé & Godard 2000) such as bare predicative elements, some specific adverbs and "floating" quantifiers. The **kernel** receives the other verbal dependants, especially all the elements that saturate the verbal valency (including the verbal chunk). Finally, we obtain the complete structure with the macro-domain which can be compared to the macrosyntactic level of Blanche-benveniste 1990: In addition to the kernel which represents the "proper" syntactic level, the macro-domain contains the *prefix* and the *postfix* fields for detached elements with specific communicative values, which do not have a direct but proleptic syntactic link with the verb. The complete verbal constraint set is as follows:

macro-domain:	*comp* < *prefix* < *kernel* < *postfix*
kernel:	*Vorfeld* < *cluster* < *Mittelfeld*
cluster:	*chunk* < *adv* < *pred*
chunk:	*neg-cl* < *me-cl* < *acc-cl* < *dat-cl* < *y-cl* < *en-cl* < *verb* < *subj-encl*

We could say that French resembles somehow to a V2 language since its *Vorfeld* is, as in German, open to a unique element. The element that goes in this field is usually the subject but other complements can occupy this place too as shows the case of (e.g. locative) inversion:

Sur la place | *se dresse* | *une cathédrale*. ('On the square stands a cathedral.')
Au terrorisme | *ne pouvait pas ne pas répondre* | *l'activisme israélien* (Le Monde, 1967).

However, when the subject is a clitic pronoun, it has to occupy the *Vorfeld*, but this field is then "aspirated" into the verbal chunk, the obligatory template for clitics. When, in this case, a locative complement is fronted it is necessarily dislocated:

Sur la place, elle se dresse. ('On the square it stands.')

A comparable phenomenon of "aspiration" appears when the complementizer is also a verbal dependent: The left dislocation is possible in French completives and ungrammatical in relatives:

Je crois que, Marie, Jean ne lui donne plus d'argent. ('I think that, Mary, John doesn't give her money')
**l'argent que, Marie, Jean lui donne* ('the money that, Mary, John gives her')
l'argent que Jean donne à Marie ('the money that John gives to Mary').

Our double system of constraints accounts perfectly for this ungrammaticality: The relative pronoun saturates the valence of the verb and must go into the kernel (as any other verbal argument would). But since it occupies the *comp* field of the macro-domain, there can no longer be a *prefix* field (because the *prefix* field disappears when the *comp* field is aspirated in the kernel)!
Moreover, the aspiration can even cause a fusion with the *Vorfeld*, the first field of the kernel, which explains the optional subject inversion in relatives:

le livre que Pierre lit; *le livre que lit Pierre*. ('the book that Peter reads').

This fusion is obligatory for the placement of the subject relative pronoun *qui*:

**la cathédrale qui sur la place se dresse*. ('the cathedral that on the square stands').

The same process goes even further with the interrogative pronoun *que* which is a clitic: In this case, the *comp* field is aspirated all the way into the verbal chunk causing on its way the disappearance even of the *Vorfeld:*

Que veut-il faire ? ('What does he want to do ?)
**Que Pierre veut-il faire ?* ('What does Peter want to do ?)
A qui Pierre veut-il parler ? ('To whom does Peter want to talk ?).

Of course, chunk, cluster, and kernel also play other roles in the description. We find the same type of constraints in German where non-stressed pronouns of the *Mittelfeld* must be close to the verb while adverbs precede the other complements.

It is imaginable to apply the topological constraints without preserving the combined topological structure: Either we just keep the word string or we keep parallel topological structures for each type of order constraints (syntactic, communicative, rhythmic… constraints). (One could suppose that

syntactic and communicative constraints act independently, constructing two different families of constituent trees. It could be argued that the resulting acceptable linearizations are those appearing in both tree families.) In the remaining of this paper we show that these alternatives make the computation of the next representation in the generation process more complex.

3. From topology to phonology

It holds for any representation level in the MTT framework that the justification for the independence of the level stems from the ease in describing the correspondences with the neighboring representations. Or, to put it differently, MTT presupposes the existence of 7 levels in its language model, because the breaking up of the meaning-sound correspondence makes the description of language easier. Thus, we have to show that the topological tree is not a mere byproduct of the linearization process: We have to show the usefulness of the topological tree structure in the following correspondence, in the topology-phonology interface.

We discuss three examples indicative of the necessity of the topological structure and the insufficiency of pure word strings for the computation of the prosodic structure (and thus of the sound output):

3.1 German

The verbal domain for the so-called "Verlaufsform" (partial nominalization of an infinitive) obliges a contraction of the preposition and the determiner whereas a nominal domain allows also not to contract (and communicative constraints apply to choose among the two possibilities):

*Maria ist am (*an dem) Schlafen.* ('Maria is sleeping.')
Maria sitzt [am / an dem] Tisch. ('Maria is sitting at the/that table').

Another possibility to handle this problem is to consider the two cases of "dem" as different words, as in English where the definite and demonstrative articles differ. For German this approach results in an ambiguity for every single article. Moreover, we would have to keep morpho-syntactic information in the linearized representation. In a topological approach we can abstract away from this and even the distinction between article and relative pronoun is not needed for the computation of the sound output: The topological domain structure allows us to recognize that the "an dem" string in the following sentence cannot be contracted as the words belong to different domains: *Maria gab das Script an* [*dem die Daten zu übergeben sind*]. ('Maria specifies the script [to which the data has to be passed on]')

3.2 French

Similarly, the French flat topological structure is sufficient for the computation of the correspondence with the phonological representation. Even though the verb cluster ("amas verbal") is a more constraint domain concerning for example extraction and insertion of parenthetical clauses, the border of this domain is neither essential for the computation of prosodic groups nor for the placement of parentheticals (e.g. parentheticals can be placed at different places, among them before the verbal dependant inside the verb clusters: *Il a voulu vraiment, c'est Jean qui me l'a dit, acheter cet appartement* 'He really wanted, John told me that, to buy this flat.').

The phenomenon of liaison (and elision) in French can illustrate the fact that the internal structure of topological constituents are necessary for the computation of the next level. The following example illustrates that some positions are obligatory [z], optional ([z]), or forbidden # for liaison:

Les petits [z] *enfants* ([z]) *intelligents* # *étaient malades.* 'The little intelligent children were sick.'

We stipulate that liaison can only take place inside a constituent (and not via constituent borders). The optional character of the liaison between *enfants* and *intelligents* stems from the fact that the flat nominal domain has been obtained from a simplification of an embedded structure where determiner, pre-posed adjective, and noun formed a nominal chunk, thus excluding *intelligents*. This explains the topology–phonology rule that allows us not to realize a liaison between the noun field and the post-posed adjective field. Without the topological structure, we would need to stipulate ad-hoc rules of the existence of liaison between certain categories of words.

Moreover, the topological structure is necessary to explain different levels of prosodic breaks as in the following example (more important breaks are indicated by higher number of bars):

Le départ | *de Paris* || *de Marie* ||| *est repoussé.* ('Mary's departure from Paris is put off.').

These borders follow naturally from the topological constituent structure:

[*Le départ* [*de Paris*] [*de Marie*]] *est repoussé.*

It is easy to see that the first border (*depart – de*) is topologically less important than the second border (*Paris – de*). The higher importance of the last border (*Marie – est*) stems from the fact that we are leaving all nominal domains to continue in the (verbal) main domains.[3]

3.3 Greek

Greek clitics do not bear lexical stress. In some special positions, however, we can assign them secondary stress if they are in an enclitic position. The example below is ambiguous two groupings depending on whether the clitic *mou* 'my/me' is part of the nominal domain ([*i Despina mou*] *to edose*) or of the verbal domain ([*i Despina*] *mou to edose*). If it is part of the nominal domain, then it will obtain a secondary stress,[4] otherwise it will not. On a suprasegmental level, the decision of putting the corresponding contours will depend on the position of the clitic in the topological structures.

i	*Despina*	*mou*	*to*	*edose*
det	Despina my/me	it	gave	

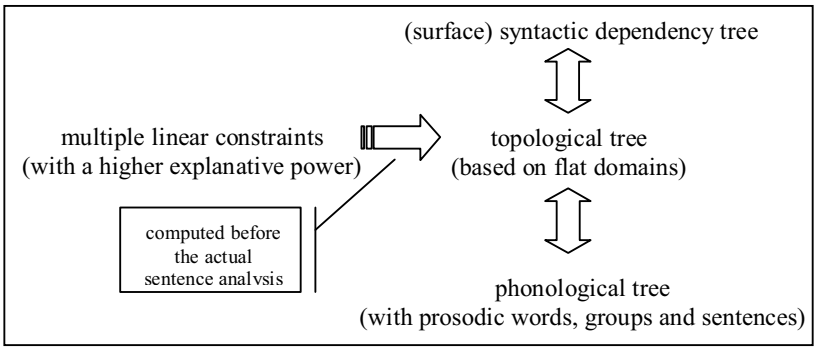
'Despina gave it to me' or 'My Despina gave it"

We see that the topological structure, and not just the word order, is crucial for the correspondence with the phonological level. Without the topological structure, it would only be possible to obtain the correct grouping under two conditions:

1. The prosodic grouping is assigned before the words are constructed (which has been shown to be difficult in Yoo 2003a);
2. We need quite complex *ad hoc* rules for assigning the frontiers that take into account categorical and syntactic information.

Conclusion

Looking at these results for various languages, we can conclude that topology is more than just a computational tool among others to compute word order, but it is a self-sufficient linguistic structure. It is clear that we have to distinguish the explanatory part from the computational part of topology. When explaining word order or phonological constraints, we sometimes refer to simpler linear constraints. However, these domains do not appear in the topological structure as they are, but they are used to construct the actual domains of the topological structure. The absence of the "explanatory" constraints from the topological structure can be justified by the fact that they have no direct relevance for the computation neither of the syntax-topology interface nor of the topology-phonology interface.
The (explanatory) constraints of different domains are overlaid to form combined flat domains when



[3] This latter border is even more enhanced by the fact that in the original constraint sets that constructed the (flattened out) domain, we had the *chunk* and *cluster* opening at this position:

[[*Le départ*] [*de Paris*] [*de Marie*]] [[*est*]$_{\text{chunk}}$ *repoussé*]$_{\text{cluster}}$.

This shows again how the original constraints explain some topology–phonology correspondence rules.

[4] Following the trissylable rule, we can assign a secondary stress on unstressed syllables when the primary stress is followed by three unstressed syllables. In our example, the noun *Despina* is stressed on the antepenultimate syllable: if the clitic is part of the noun domain, it can get a secondary stress while when it is part of the verbal domain, the trissylable rule does not apply.

constructing the grammar. The following diagram may recall the base generated deep structure and the corresponding surface structures of Government and Binding Theories, but our language model is completely different in that the actual computation of the Meaning-Text correspondence for a given sentence does not include the multiple constraint domains but only the combined flat structures.
The topological structure is necessary for a complete description of word order phenomena independently of the language to describe and independently of the model chosen for the formalisation. A topological grammar takes into account syntactic and communicative order constraints and allows in this way a typological classification of languages. Moreover, we have shown that topology is not only needed for the linearization process of the dependency tree but also for the next step, the computation of prosodic groups. However the actual domains (and thus the syntax-topology and topology-phonology correspondence rules) are often the result of the combination of various order constraints with a higher explanatory power than the resulting domains themselves. Ongoing work on various languages and phenomena tends to verify the descriptive power of the topological formalization.

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