# Topic-Focus Articulation in SDRT

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## 1. Introduction

The work described here is part of a larger effort to develop a theory of discourse representation for Czech based on the Praguian framework of Functional Generative Description (FGD, [Sgall et al., 1986]). We depart from FGD in that we aim at a framework for analysis. Given an utterance of a sentence in a discourse, we want to analyze that sentence through a process of (1) constructing its tectogrammatical representation(s) reflecting the meaning potential of the sentence, and (2) building an interpretation with respect to the larger context in which the sentence occurs. In this paper we will be concerned with the latter process that takes a tectogrammatical representation (TR) of a sentence as an input and yields a TFA-sensitive interpretation of an utterance of a sentence anchored in a larger discourse context.

We aim on the one hand to extend the Praguian framework with a treatment of discourse phenomena, and on the other hand to modify the discourse representation theory by taking information structure into account. Since the information structure of a sentence, in FGD referred to as the topic-focus articulation (TFA), is one of the essential notions reflected in the TR, it is possible to exploit it in the course of further processing. We propose a modification of the basic DRT fragment [Kamp and Reyle, 1993] which serves as the first step in developing a TFA sensitive version of Asher's SDRT [Asher, 1993].

Our approach shares some underlying ideas with the approach advocated by Vallduví [Vallduví, 1994]. One difference between our approaches is a difference in the description of information structure: whereas in Vallduví 's information packaging one works with the ground-focus dichotomy in which the ground may be further subdivided into a link and a tail, the TFA in FGD is seen as the topic-focus dichotomy without any further subdivision, but with an ordering of the items included in the topic and in the focus along the scale of communicative dynamism. Furthermore, the two approaches differ in respect of which sentences are classified as all-focus. In the example below, (1a) shows the information packaging accordingg to Vallduví, and (1b) shows the topic-focus dichotomy according to FGD.

What can you tell me about the president? He likes BROCOLI.

(a) $[_F$ he likes BROCOLI$]$

(b) $[_T$ he$]$ $[_F$ likes BROCOLI$]$

Our approach to discourse representation differs from Vallduví's in that we employ the DRT-based perspective rather than the file-change metaphor. We treat the topic of a sentence as presupposed material which needs to be anchored in the representation of the disocurse built so far. In terms of our modifcation of DRT, topic-focus articulation plays a role in determining the appropriate attachmentsite and it can constrain the discourse relation used in attachment.

In the rest of this abstract we proceed as follows. We overview some of the essential notions and intuitions originating from the FGD framework. We define a translation of a subset of the TRs into corresponding pseudo-logical forms inspired by Peregrin's [Peregrin, 1995], called the $\lambda$-*TRs*. A $\lambda$-TR represents the topic-part and focus-part of a sentence by two related $\lambda$-expressions. We then define construction of a sentence-DRS out of a $\lambda$-TR and we sketch the conditions for attaching a sentence-DRS to an existing DRS. Due to the restricted length of this abstract, we cannot present all the necessary formal specifications.

## 2. Tectogrammatical representation

The FGD framework defines a dependency grammar approach to the description of language [Sgall et al., 1986]. FGD works with several levels of representation, one of which is the tectogrammatical representation which represents the linguistic meaning. A TR is a structure that captures (i) *syntactico-semantic relations* between lexical items, reflecting their dependency and coordination relationships, (ii) the *distinction between contextual boundness and non-boundness* for each lexical item which indicates whether an item relates to already established context or is a modification or extension of it, and (iii) the *scale of communicative dynamism*, reflecting deep (underlying) word order.[1]

Henceforth, we shall use a linearized form to write down TRs. The TR of the sentence in (1) is written as follows:

(1′) [[ACT:he$^{cb}$] ROOT:like$^{nb}$ [PAT:brocoli$^{nb}$]]

## 3. Topic-focus articulation

In FGD, the *topic-focus articulation* (TFA) is a secondary notion defined as a dichotomy derived on the basis of countextual boundness. For primary cases, TFA is specified as follows [Sgall et al., 1986]:

(i) The main verb belongs to the focus iff it is contextually nonbound (NB), and to the topic iff it is contextually bound (CB).
(ii) The NB nodes depending on the main verb belong to the focus, and so do all nodes that are subordinated (transitively dependent) to these NB nodes.
(iii) If some of the elements of the TR belong to the focus, as according to (i) and (ii), then every CB node dependent on the main verb, together with all the nodes subordinated (transitively dependent) to these nodes, belong to the topic.
(iv) If no node of the TR fulfils (i) nor (ii), then the focus is probably more deeply embedded.

We do not need a more complex definition for the purpose of this paper.

## 4. From TR to $\lambda$-TR

In a recent article [Peregrin, 1995], Peregrin proposed extensional semantics of formulas of the form P{S}, as the predication of P, corresponding to the focus-part of a sentence, of S, corresponding to its topic-part. His approach offers a formalization of the intuition that the topic of a sentence is what the sentence is about and the focus is what the sentence says about its topic, that the topic is connected with a presupposition and that focus tends to be interpreted as exhaustive. In the following section we sketch how we take Peregrin's proposal further.

We define $\lambda$-TRs of the form $F\{T\}$ which serve as an intermediate step between a TR and a TF-DRS.Our $\lambda$-TRs preserve the structure of a TR which is relevant for further processing.

In the current paper we confine ourseves to the *nucleus TRs*, i.e. the TRs which consist only of the *nucleus* and no other nodes. The TR nucleus consists of the root-node of the TR, corresponding to the main verb of the sentence, and the nodes directly dependent on it corresponding to complementations of the verb realized by nouns (in various cases, expressed with or without a preposition) or adverbs. An example of a nucleus TR is shown in (1′) above.

The nominal complementations can correspond to the inner participants, i.e. depending on the verb as the ACTOR (ACT), PATIENT (PAT), ADDRESSEE (ADR), ORIGIN (ORI), EFFECT (EFF), or to the free modifiers expressed by prepositional

[1] A more detailed introduction to FGD can be found in Kruijff's paper in these proceedings.

noun groups, e.g. LOCATION (LOC), DIRECTION (DIR), INSTRUMENT (INS), TIME (TM), MANNER (MNR). The adverbial complementations correspond to the free modifiers expressed by adverbs, e.g. LOCATION, DIRECTION, TIME, MANNER. A nuclear TR does *not* contain complementations of anything else than the verb.

Essentially, there are two possibilities for the TFA of a nucleus TR, depending on whether the verb occurs as CB or NB, and therefore belongs to the topic or to the focus, respectively. These two possibilities are illustrated below [2]:

(1) [What can you tell me about the president?] He likes BROCOLI.
[[ACT:he$^{cb}$] ROOT:like$^{nb}$ [PAT:brocoli$^{nb}$]]
$\lambda$x. like(ACT:x,PAT:brocoli) {$\lambda$Q. Q(ACT:he)}

(2) [What does the president like?] He likes BROCOLI.
[[ACT:he$^{cb}$] ROOT:like$^{cb}$ [PAT:brocoli$^{nb}$]]
$\lambda$Q. Q(PAT:brocoli) {$\lambda$y. like(ACT:he,PAT:y)}

The TFA boundary thus always immediately precedes or follows the root-node.

**Definition 1. $\lambda$-TR for a nucleus TR** *The $\lambda$-TR corresponding to a TR $\tau$ has the form $F\{T\}$ where $F$ stands for the Focus-part, and $T$ stands for the Topic-part of $\tau$. Given a nucleus TR $\tau$ containing the main-verb node, $\alpha$, with $m+n$ nodes modifying it by dependency relations $D_1, \ldots D_{m+n}$, let us assume there are one or more CB complementation-nodes, $\beta_1, \ldots, \beta_m$ modifying $\alpha$ by dependency relations $D_1, \ldots D_m$, respectively , and one or more NB complementation-nodes, $\gamma_1, \ldots, \gamma_n$, modifying $\alpha$ by dependency relations $D_{m+1}, \ldots D_n$, respectively. Then the Topic part constituting the $\lambda$-TR is obtained by $\lambda$-abstracting over the NB nodes, and the Focus part is obtained by $\lambda$-abstracting over the CB nodes. The respective $\lambda$-expressions have the following shape:*

1. *iff the main-verb node is NB:*
$T = \lambda Q.Q(D_1 : \beta_1, \ldots, D_m : \beta_m)$
$F = \lambda X_1, \ldots \lambda X_m \alpha(D_1 : X_1, \ldots, D_m : X_m, D_{m+1} : \gamma_1, \ldots, D_{m+n} : \gamma_n)$
2. *iff the main-verb node is CB:*
$T = \lambda X_1, \ldots \lambda X_n \alpha(Dep_1 : \beta_1, \ldots, Dep_m : \beta_m, D_{m+1} : X_1, \ldots, D_{m+n} : X_n)$
$F = \lambda Q.Q(D_1 : \gamma_1, \ldots, D_m : \gamma_m)$

*Special cases:*

- *all complementation-nodes are NB ($m = 0$), and:*
  1. *the main-verb node, $\alpha$, is also NB:*
  $T = \lambda Q.Q$
  $F = \alpha(D_1 : \gamma_1, \ldots, D_n : \gamma_n)$
  2. *the main-verb node, $\alpha$, is CB:*
  $T = \lambda X_1, \ldots \lambda X_n \alpha(D_1 : X_1, \ldots, D_n : X_n)$
  $F = \lambda Q.Q(D_1 : \gamma_1, \ldots, D_m : \gamma_m)$
- *all complementation-nodes are CB ($n = 0$): the main-verb node, $\alpha$, is the only NB node (because there must be at least one NB node in a well-formed TR), and the $\lambda$-TR has the following shape:*
$T = \lambda Q.Q(D_1 : \beta_1, \ldots, D_m : \beta_m)$
$F = \lambda X_1, \ldots \lambda X_m \alpha(D_1 : X_1, \ldots, D_m : X_m)$

Some Czech examples of $\lambda$-TRs with different structure are show below:[3]

[2] We use the usual typographical convention of depicting phonological focus by CAPITALS. It should be noted that we do no distinguish between different kinds of tunes, e.g. we do not have a special notation to mark constrast. Underlining depicts the items belonging to the focus-part of the utterance. We provide short questions to specify the intended context of use for a particular utterance. These questions should be seen along the lines of a question-test, rather than as in a question-answer pair in a dialogue.

[3] We use English equivalents of the Czech words in the $\lambda$-TRs for the sake of legibility for a reader unfamiliar with the Czech language.

(3) [Kdo dneska spálil topinku? (*En.* Who burned a/the toast today?)]
Dneska topinku spálil <u>JAN</u>. (*En.* <u>JOHN</u> burned the toast today.)
$\lambda Q.Q(ACT: john)\{\lambda X_1.burn(ACT: X_1, PAT: toast, TM: today)\}$

(4) [Co Jan dneska spálil? (*En.* What did John burn today?)]
Dneska spálil <u>TOPINKU</u>. [4] (*En.* He burned <u>the TOAST</u> today.)
$\lambda Q.Q(PAT: toast)\{\lambda X_2.burn(ACT: he, PAT: X_2, TM: today)\}$

(5) [Kdy Jan spálil topinku? (*En.* When did John burn a/the toast?)]
Jan topinku spálil <u>DNESKA</u>. (*En.* John burned the toast <u>the TODAY</u>.)
$\lambda Q.Q(TM: today)\{\lambda X_3.burn(ACT: john, PAT: toast, TM: X_3)\}$

(6) [Co se stalo s topinkou? (*En.* What happened to the toast?)]
<u>Jan</u> ji <u>SPÁLIL</u>. (*En.* <u>John BURNED</u> it.)
$\lambda X_2.burn(ACT: john, PAT: X_2)\{\lambda Q.Q(PAT: toast)\}$

(7) [Co Jan udělal? (*En.* What did John do?)]
Jan <u>spálil TOPINKU</u>. (*En.* John <u>burned a TOAST</u>.)
$\lambda X_1.burn(ACT: X_1, PAT: toast)\{\lambda Q.Q(ACT: john)\}$

## 5. From λ-TR to sentence-DRS

The first issue to be tackled when we want to construct a DRS corresponding to a given λ-TR is the assignment of discourse referents. We define a function, Θ, which transformes a λ-TR into a DRS. We use some of the formal machinery introduced for λ-DRT [Kuschert, 1995]: for merging DRSs, we employ the ⊗ operator, and for the construction of DRSs we employ the name- sensitive δ-abstraction operator which binds free variables across β-reduction and serves to declare discourse referents . We also employ the same linear notation for DRSs. We introduce the ⋈ operator which connects the λ-DRS corresponding to the topic of the sentence and the λ-DRS corresponding to its focus. This operator binds weaker than the λ-abstraction operator, the δ-abstraction operator and the merge operator, ⊗.

**Definition 2. Transformation of a λ-TR into a DRS**

*Given a λ-TR of the form $F\{T\}$ where $F$ stands for the Focus-part, and $T$ stands for the Topic-part, the λ-TR transformation function, Θ, is defined as follows:*

1. $\Theta(F\{T\}) = \Theta(T) \bowtie \Theta(F)$
2. $\Theta(\lambda Q.Q(D_1: \upsilon_1, \ldots, D_n: \upsilon_n)) =$
   $\lambda Q.(Q(D_1: \upsilon'_1, \ldots, D_n: \upsilon'_n) \otimes \Gamma_1 \otimes \ldots \otimes \Gamma_n)$
3. $\Theta(\lambda X_1 \ldots \lambda X_m.\alpha(D_1: \upsilon_1, \ldots, D_n: \upsilon_n)) =$
   $\lambda X_1 \ldots \lambda X_m.(\alpha(D_1: \upsilon'_1, \ldots, D_n: \upsilon'_n) \otimes \Gamma_1 \otimes \ldots \otimes \Gamma_n)$

*where*

- $\upsilon'_i = r_x and K_i = \delta\{\}.T$ *iff* $\upsilon_i$ *is a pronoun*
- $\upsilon'_i = r_{k+1} and K_i = \delta\{r_{k+1}\}.r_{k+1} = r_x \wedge \upsilon_i(X_{k+1})$ *iff* $\upsilon_i$ *is a* CB *noun*
- $\upsilon'_i = r_{k+1} and K_i = \delta\{r_{k+1}\}.\upsilon_i(r_{k+1})$ *iff* $\upsilon_i$ *is an* NB *noun*
- $\upsilon'_i = \upsilon_i \Gamma_i = \delta\{\}.T$ *iff* $\upsilon_i$ *is an adverb*

*The meaning of the symbols is as follows: $K_j$ is a λ-DRS, $k$ is the index of the most recently declared discourse referent, $r_i$ means the i-th discourse referent, $r_x$ means an as yet undetermined discourse referent corresponding to the antecedent of an anaphoric expression, $\upsilon$.*

The familiarity-novelty distinction in the declaration of discourse referents in 2 is oversimplified in that clauses (1) and (2) handle all pronouns and CB nouns

[4] Czech is a pro-drop language. We assume that the dropped Subject corresponding in this case to the Actor-slot of the verb in the Czech TR, is filled by some dummy symbol. The grammatical number and gender are carried by the verb. We treat the dummy symbol as a special kind of pronoun, as it can only occur in the Subject position.

as co-referential with some antecedent, and clause (3) handles all NB nouns as introducing a new discourse referent.

We show examples of applying $\Theta$ below:

(8) [Co se Janovi ráno stalo? (*En.* What happened this morning to Jan?)]

1. Jan ráno opékal CHLEBA. (*En.* Jan toasted BREAD.)
$\Theta(\lambda X_1.\lambda X_3.toast(ACT : X_1, PAT : bread, TM : X_3)\{\lambda Q.Q(TM : X_3)\}) =$
$\lambda Q.Q(ACT : r_1, TM : X_3) \otimes \delta\{r_1\}.r_1 = r_x \wedge jan(r_1) \bowtie$
$\lambda X_1.\lambda X_3 toast(ACT : X_1, PAT : r_2, TM : X_3) \otimes \otimes\delta\{r_2\}.bread(r_2)$
2. SPÁLIL ho. (*En.* He BURNT it.)
$\Theta(\lambda X_1.\lambda X_2.burn(ACT : X_1, PAT : X_2)\{\lambda Q.Q(ACT : he, PAT : it)\}) =$
$\lambda Q.Q(ACT : r_3, PAT : r_4) \otimes \delta\{\}.T \otimes \delta\{\}.T \bowtie \lambda X_1.\lambda X_2.burn(ACT : X_1, PAT : X_2)$
3. Spálil VAJÍČKA. (*En.* He burnt EGGS.)
$\Theta(\lambda Q.Q(PAT : eggs)\{\lambda X_2.burn(ACT : he)\}) =$
$\lambda X_2.burn(ACT : r_5) \otimes \delta\{\}.T \bowtie \lambda Q.Q(PAT : r_6) \otimes \delta\{r_6\}.eggs(r_6)$
4. Potom odešel rychle do PRÁCE.
(*En.* Afterwards he left for WORK quickly.)
$\Theta(\lambda X_1.\lambda X_4.leave(ACT : X_1, DIR : work, MNR : quickly, TM : X_4)\{\lambda Q.Q(ACT : he, TM : afterwards)\}) =$
$\lambda Q.Q(ACT : r_7, TM : afterwards) \otimes \delta\{\}.T \bowtie \lambda X_1.\lambda X_4.leave(ACT : X_1, DIR : r_8, MNR : quickly, TM : X_4) \otimes \delta\{r_8\}.work(r_8)$

## 6. INCREMENTAL DISCOURSE-DRS CONSTRUCTION

Once a sentence-DRS has been constructed, it needs to be attached (in)to the discourse-DRS constructed so far. We define attachment to be sensitive to the topic-focus articulation of a sentence. Besides treating topic as a presupposed material, we employ the notion of *TF chaining*, which means that the topic part of a sentence is anchored to an accessible and suitable preceding topic, focus or an entire T-F nexus (or sequence thereof) [Korbayová and Kruijff]. Accessibility is the usual DRT notion defined in terms of DRS subordination.Suitability is defined in terms of unifiability of two $\lambda$-TRs. We take the whole $\lambda$-TRinto account when testing whether its topic-part can be anchored to something suitable in the preceding context, rather than unifying only the topic. The reason for this is that it enables us to test compatibility of the asserted information directly. A proper definition of attachment requires a formalization of a number of notions which needs more space then we have available in this abstract. The following is a sketch of the incremental construction of the DRS for (8), and its final result (though without additional contextual conditions obtained through anaphora resolution):

(8′) $(\lambda Q.Q(ACT : r_1, TM : X_3) \otimes \delta\{r_1\}.r_1 = r_x \wedge jan(r_1)) \bowtie$
$(\lambda X_1.\lambda X_3 toast(ACT : X_1, PAT : r_2, TM : X_3) \otimes \delta\{r_2\}.bread(r_2)) \otimes$
$(\lambda Q.Q(ACT : r_3, PAT : r_4) \otimes \delta\{\}.T \otimes \delta\{\}.T) \bowtie$
$(\lambda X_1.\lambda X_2.burn(ACT : X_1, PAT : X_2)) \otimes$
$(\lambda X_2.burn(ACT : r_5) \otimes \delta\{\}.T) \bowtie$
$(\lambda Q.Q(PAT : r_6) \otimes \delta\{r_6\}.eggs(r_6)) \otimes$
$(\lambda Q.Q(ACT : r_7, TM : afterwards) \otimes \delta\{\}.T) \bowtie$
$(\lambda X_1.\lambda X_4.leave(ACT : X_1, DIR : r_8, MNR : quickly, TM : X_4) \otimes$
$\delta\{r_8\}.work(r_8))$
$\longrightarrow^+_\beta$
$\delta\{r_1, r_2, r_6, r_8\}.r_1 = r_x \otimes$
$\lambda Q.Q(ACT : r_1, TM : X_3) \wedge jan(r_1) \bowtie$
$\lambda X_1.\lambda X_3 toast(ACT : X_1, PAT : r_2, TM : X_3) \wedge bread(r_2) \otimes$

$$\lambda Q.Q(ACT:r_1, PAT:r_2) \bowtie \lambda X_1.\lambda X_2.burn(ACT:X_1, PAT:X_2) \otimes$$
$$\lambda X_2.burn(ACT:r_1) \bowtie \lambda Q.Q(PAT:r_6) \wedge eggs(r_6) \otimes$$
$$\lambda Q.Q(ACT:r_1, TM:afterwards) \bowtie$$
$$\lambda X_1.\lambda X_4.leave(ACT:X_1, DIR:r_8, MNR:quickly, TM:X_4) \wedge work(r_8)$$

## 7. Concluding remarks

We present an approach incorporating the notion of information structure into the basic fragment of DRT. We employ the FGD view of information structure, referred to as topic-focus articulation, which is a dichotomy derived from the deep structure of the sentence. In this sense, our work implements ideas developed in the FGD framework. We represent the topic-part and the focus-part of a sentence by two related $\lambda$-terms which preserve the ingredients of the deep structure relevant for interpretation of the sentence with respect to the larger context. We present the essential ideas underlying the method of turning the $\lambda$-TR of a sentence into a DRS and incorporating it into the DRS representing the discourse in which the sentence occurs.

Including the TFA and the deep structure information, in particular dependency relations, in the DRS is useful for further discourse processing. For instance it enables a fine-grained account of coherence relationships which in turn facilitates the determination of discourse segments (in the sense of [Asher, 1993]. It also makes possible straightforward resolution of certain kinds of anaphora (using demonstrative pronouns).

Our approach easily extends to complex sentences composed of two or more subordinated or coordinated claues, which can be treated as each having their own "sub-TFA". Complex sentences can then be treated by decomposing them and relating their subparts by means of TF chaining, complemented by coherence relationships when required.

Since further elaboration of the formal apparatus sketched here and its employment in representing and interpreting discourses are subject of ongoing research, there are still many open questions and issues to be tackled. A profound comparison to the existing approaches with similar aims is therefore also under development.

## References


[Asher, 1993] Asher, N. (1993). *Referring to Abstract Objects in Discourse*, volume 50 of *Studies in Linguistics and Philosophy.* Kluwer Academic Publishers, Dordrecht.

[Dekker and Hendriks, 1994] Dekker, P. and Hendriks, H. (1994). *Comments on "The Dynamics of Information Packaging"*. In Engdahl E., editor, *Integrating Infromation Structure into Constraint-based and Categorial Approaches*, pp. 27–38, Report of the DYANA-2 project, University of Amsterdam.

[Kamp and Reyle, 1993] Kamp, H. and Reyle, U. (1993). *From discourse to logic.* Kluwer Academic Publishers, Dordrecht, the Netherlands.

[Korbayová and Kruijff] Korbayová, I. and Kruijff, G.J.M. (1996). Identification of Topic-Focus Chains. In *Approaches to Discourse Anaphora: Proceedings of the Discourse Anaphora and Anaphora Resolution Colloquium (DAARC96).* Botley, S., Glass J. and McEnery, T. and Wilson, A. (eds.). University Centre for Computer Corpus Research on Language, University of Lancaster. Technical papers, No.8, pp.165–179.

[Kuschert, 1995] Kuschert, S. (1995). *Higher Order Dynamics: Relating Operational and Denotational Semantics for $\lambda$-DRT* Research Report, University of Saaarbruecken, Germany.

[Peregrin, 1995] Peregrin, J. (1995). Topic and focus in a formal framework. In Partee, B. H. and Sgall, P., editors, *Discourse and Meaning: Papers in Honor of Eva Hajičová.* John Benjamins, Amsterdam, The Netherlands.

[Sgall et al., 1986] Sgall, P., Hajičová, E., and Panevová, J. (1986). *The meaning of the sentence in its semantic and pragmatic aspects.* Reidel.

[Vallduví, 1994] Vallduví, E. (1994). *The Dynamics of Information Packaging.* In Engdahl E., editor, *Integrating Infromation Structure into Constraint-based and Categorial Approaches*, pp. 1-26, Report of the DYANA-2 project, University of Amsterdam.