A Unified Taxonomy of Deep Syntactic Relations

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Abstract

This paper analyzes multiple deep-syntactic frameworks with the goal of creating a proposal for a set of universal semantic role labels. The proposal examines various theoretic linguistic perspectives and focuses on Meaning-Text Theory and Functional Generative Description frameworks.

For the purpose of this research, data from four languages is used – Spanish and Catalan (Taulé et al., 2011), Czech (Hajič et al., 2017), and English (Hajič et al., 2012).

This proposal is oriented towards Universal Dependencies (de Marneffe et al., 2021) with a further intention of applying the universal semantic role labels to the UD data.

1 Introduction

Linguistic research and multilingual natural language processing need annotated data in many languages, ideally following a uniform annotation framework. For morphology and surface syntax, Universal Dependencies $(UD)^1$ (de Marneffe et al., 2021) is the current de-facto standard of such a framework. Nevertheless, despite being an important linguistic resource, UD is only one step towards natural language understanding. The mapping between surface syntax and meaning is not straightforward, as the same meaning can be encoded in various syntactic constructions (e.g., active vs. passive clauses), and vice versa, one syntactic construction can be used to convey different meanings (e.g., the English preposition on can express location, time, or other verb-specific roles as in *I rely on him*). Therefore there are datasets that attempt to annotate another layer (or multiple layers) of the language, which is closer to the meaning and is variously termed 'deep-syntactic', 'tectogrammatical', or even 'semantic'. Unfortunately, the annotations in this layer have not reached the

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level of cross-linguistic uniformity and interoperability that UD set for morphology and surface syntax.

Deep-syntactic annotation can cover a variety of phenomena but in the present paper, we focus on the inventory of deep-syntactic (or semantic) relations between words. We study the inventories used in existing annotation frameworks, compare them and propose a unified inventory where the same meaning would have the same label across datasets. This unified set of relations should be applicable to any language. Ideally, it should be possible to map relations from existing frameworks onto this inventory without loss of information; while there is no guarantee that this ideal goal is achievable, we want to get as close to it as possible.

There are two related projects worth mentioning here. Universal Proposition Bank (Jindal et al., 2022) provides semantic role annotation for 23 languages, based on their UD treebanks. As the name suggests, semantic role labels follow the PropBank (Kingsbury and Palmer, 2002). Second, a recent proposal by Evang (2023) defines the CRANS annotation scheme to annotate semantic roles on top of UD. Only a few coarse and cros-linguistically applicable valency frames (superframes) are defined in CRANS in order to avoid reliance on largecoverage language-specific valency dictionaries.

The paper is organized as follows. We first (Section 2) give a brief overview of annotation frameworks that we considered for this study, explaining how we selected the ones to focus on in the rest of the paper. In Section 3, we survey the deepsyntactic relations in Meaning-Text Theory, in Section 4 we do the same with Functional Generative Description. Finally, in Section 5 we propose a unified set of relations to which the other two can be mapped.

¹https://universaldependencies.org/

2 **Selection Criteria**

To be able to work with the most relevant frameworks, the framework selection criteria and terminology proposed in (Žabokrtský et al., 2020) is re-used and adapted. Although the purpose of this survey is to provide an overview of how sentence meaning is represented in selected deep-syntactic frameworks, it also provides both a direct comparison to UD and also suggestions for a discussion on a unifying approach to sentence meaning. This makes it a natural point of departure for this research by creating a proposal for universal semantic role labels.

This work is directly related and built upon UD. It is therefore focused on meaning representations whose backbone structure can be described as a graph over words (possibly with added non-lexical nodes) corresponding to entities, events, properties, or circumstances, with edges representing meaningful relationships among them. Basic UD is the surface sentence representation. Thus, approaches that handle only the original sequence of word forms and do not make any abstraction above overt morphological, lexical, or syntactic means are not included.

2.1 Basic Criteria

Similar to Žabokrtský et al. (2020), this research only includes frameworks capable of analyzing whole authentic sentences of natural languages. Purely lexicographical approaches are not included.

The paper examines approaches that have been extensively studied for a longer period of time, and have been utilized in natural language applications.

Another important criterion addresses data availability – whether a framework has enough data, meaning that the framework has a publicly available associated corpus of a reasonable size or is available in the main part of the Linguistic Data Consortium catalog.

The pre-selection of frameworks including associated corpora and major lexicographical resources was taken from Žabokrtský et al. (2020) (Table 1) and further refined into a short list of deep-syntactic frameworks that was used for the proposal.

2.2 Additional Criteria

As it was mentioned in Section 2, this proposal for universal semantic role labels is oriented towards UD, meaning that the proposal must be built

upon existing guidelines and take into account UD specific features:

- Representation: Basic representation and Enhanced representations (Schuster and Manning, 2016) are available in UD (Zeman, 2021), although for the majority of languages the enhanced representation still has to be generated automatically (Droganova and Zeman, 2019). The two graphs are stored in the same file side-by-side. In many cases the basic tree is a subset of the enhanced graph, but it is not guaranteed.² The universal deep-syntactic relations must extend the enhanced representation without breaking it.
- Content vs. Function Words: Regardless of the chosen representation, in UD, function words have nodes of their own, but they are attached to content words and treated like their attributes.
- Data structure: The enhanced UD graph is typically quite close to the rooted tree of the basic representation - the two structures can be identical. Propagation of dependencies across coordination and propagation of arguments of control verbs may cause the tree to become a directed acyclic graph (DAG). Cycles appear only in sentences with relative clauses. The enhanced UD graph can also include empty (copied) nodes for deleted predicates so their arguments and adjuncts are reasonably attached to the graph.

Taking a closer look at the frameworks listed in Table 1 it turns out that some of the frameworks do not satisfy all the criteria listed above or match UD-specific features, thus they were not included in this research:

- Paninian Framework: This framework defines 6 karaka relations (Bharati et al., 1996). The relations are very coarse-grained and do not directly correspond to semantic roles. However, the main reason for not including this framework is data availability.³
- Enju Predicate-Argument Structures: Enju structures distinguish three types

²Sometimes a basic edge is omitted from the enhanced graph. ³At the time of writing this paper, the data was not available

in LDC or any open-access repository.

Framework	Associated corpus	Lexical resource	Languages
1. Paninian framework	HDTB, UDTB		hi, ur, bn, te
2. Meaning-text theory (MTT)	SynTagRus, AnCora-UPF	ECD	ru, en, es, fr
3. Functional Generative Description (FGD)	PDT, PCEDT	PDT-VALLEX	cs, en
4. PropBank	PropBank + NomBank + PDTB	PropBank lex.	en, ar, zh, fi, hi, ur, fa, pt, tr, de, fr
5. FrameNet-based approaches		FrameNet	en, de, fr, ko
6. Enju	Enju Treebank		en, zh
7. DELPH-IN	DeepBank	ERG	en, de, es, ja
8. Sequoia	Sequoia		fr
9. Abstract Meaning Representation (AMR)	AMR Bank	PropBank lex.	en, zh, pt, ko, vi, es, fr, de
10. Universal Conceptual Cognitive Annotation (UCCA)	English Wiki, parallel fiction, etc.		en, de, fr
11. Enhanced Universal Dependencies	Universal Dependencies		ar, bg, cs, en, et, fi, it, lt, lv, nl, pl,
			ru, sk, sv, ta, uk

Table 1: Selection of frameworks including associated corpora and major lexicographical resources from (Žabokrtský et al., 2020)

of arguments: ARG1 (semantic subject), ARG2 (semantic object), and MODARG (modifier) (Yakushiji et al., 2005). These types of arguments are too coarse-grained for the purpose of this research.

- Abstract Meaning Representation: In AMR, sentences are represented as directed graphs that treat non-leaf nodes as variables and only leaf nodes are labeled with concepts (Banarescu et al., 2013). Nodes in an AMR graph are unordered; Any correspondence between nodes and surface strings is hidden by design, making mapping to surface representation extremely unreliable.
- FrameNet-Based Approaches: In this approach semantic relations in a sentence are represented using the FrameNet semantics framework (Fillmore, 1976; Fillmore and Baker, 2001). The FrameNet project is a lexical database of English based on examples of how words are used in actual texts it consist of frame elements whose labels are chosen with regard to the particular situation making the labels extremely fine-grained and not practical for this proposal. Although FrameNet-like databases have been built for a number of languages,⁴ aligning the FrameNets across languages is work in progress.
- Universal Conceptual Cognitive Annotation (UCCA): UCCA graphs distinguish terminal and non-terminal nodes (Abend and Rappoport, 2013). Terminal nodes are anchored in the surface text making words and

multi-word chunks their labels. Non-terminal nodes do not have labels and can be characterized in terms of the categories of its outgoing edges. Edges are labeled with 12 coarsegrained categories, such as P - Process, A - Participant, D - Adverbial, E - Elaborator, and N - Connector. The way the categories were designed makes them quite difficult to map to other frameworks. For instance, the Participant label includes both Agent/arg0 and Patient/arg1, making these categories indistinguishable.

In view of considerations above the following short list of deep-syntactic frameworks was created:

- 1. Meaning-Text Theory (Žolkovskij and Mel'čuk, 1965)
- 2. Functional Generative Description (Sgall, 1967)
- 3. PropBank (Kingsbury and Palmer, 2002)
- 4. Sequoia (Candito et al., 2014)

In the present paper we focus on the perspective of the Meaning-Text Theory and Functional Generative Description, leaving the comparison to the other two frameworks for future work.

3 Meaning-Text Theory

3.1 Overview

The goal of the Meaning-Text Theory (MTT) is to write systems of explicit rules that express the correspondence between meaning and text (or sound) in various languages (Kahane, 2003). The Meaning-Text approach to language was put forward in the framework of research in machine translation in the early 1960s (Žolkovskij and Mel'čuk,

⁴The FrameNet web page (https://framenet. icsi.berkeley.edu) mentions French, Chinese, Brasilian Portugese, German, Spanish, Japanese, Swedish, and Korean

1965) and since then has been extensively worked on. The correspondence between meanings and texts is completely modular. MTT defines a sevenlevel representation that describes the relation between form and meaning:

- surface-phonological representation (text)
- · deep-phonological
- surface-morphological
- · deep-morphological
- surface-syntactic
- deep-syntactic
- semantic representation (meaning)

MTT utilizes dependency, which means that on the deep-syntactic level the structure of a sentence corresponds to a rooted directed acyclic graph⁵ where nodes correspond to content words and can be ordered following the surface word order, and edges represent dependency relations between nodes. A deep-syntactic graph may contain copied nodes that are used to represent controlled subjects or elliptic constructions. The set of relations used in MTT is rather coarse-grained. It consist of a set of numbered arguments expressing their degree of proximity to the predicate, and "utility" relations such as ATTR for attributes and other modifiers, COORD for coordination, and APPEND for parentheses, interjections, and other similar items. MTT can be characterized by the massive relocation of syntactic information into the lexicon. The lexicon in MTT is represented by an explanatory combinatorial dictionary (ECD) (Mel'čuk, 2006), which includes entries for all of the lexical items of a language along with information on their combinatorics and specific rules. Lexical relations among lexemes in the lexicon are captured by Lexical Functions (LF).

The MTT scheme is applied in a corpus for Russian (SynTagRus) and two treebanks for Spanish and Catalan (AnCora 2.0). Although SynTagRus (Apresjan et al., 2006) contains morphological annotation, surface-syntactic dependency trees, lexical semantic and lexical-functional annotation, the deep-syntactic and semantic annotation seems unavailable yet. Therefore, this research only considers data from AnCora.

3.2 Available Data

UD_Spanish-AnCora and UD_Catalan-AnCora are two available treebanks that provide original semantic role labels. The original annotation was done in a constituency framework as a part of the AnCora project (Taulé et al., 2008). The corpora were converted to dependencies and used in the CoNLL 2009 shared task (Hajič et al., 2009) and later converted to Universal Dependencies (Martínez Alonso and Zeman, 2016). Table 2 shows the number of sentences and tokens for each corpus.

The two corpora consist mainly of newspaper texts annotated at morphological, syntactic, and semantic levels. Table 5 shows 20 thematic role labels and their frequencies. The frequencies are similar in both treebanks (see Figure 1 and Figure 2). Each label can be combined with argument position (see Description in Table 5 in Appendix B). The arguments required by the verb sense are incrementally numbered, expressing their degree of proximity in relation to its predicate (Palmer et al., 2005). There are seven possible argument slots: arg0, arg1, arg2, arg3, arg4, argM and argL, where adjuncts are tagged with argM and lexicalized complements of light verbs are marked with argL.

3.3 Thematic Roles

Taulé et al. (2011) describe a set of 20 thematic roles in detail. Each of the roles can be mapped to several syntactic functions and argument positions.

The roles are based on Lexical Semantic Structure (LSS) – the concept defined assuming lexical decomposition (Levin and Rappaport Hovav, 1994; Rappaport Hovav and Levin, 1998). LSS determines the number of arguments that a verbal predicate requires and the thematic roles of these arguments, and describes the syntactic functions of the arguments. Each LSS restricts the set of all possible diatheses and each verb sense is associated to one LSS. Diatheses must be understood as the syntactic expression of a semantic opposition (Taulé et al., 2011).

The subsections below provide a closer look at the AnCora data and show examples of each role in different syntactic positions.⁶ The examples are taken from the Spanish data; the data for Spanish and Catalan is of the same origin and has a similar

⁵But the structure can contain cycles in case of coreference.

⁶The examples are selected according to the frequency of their syntactic labels.

Set	UD_Spanish-AnCora, sent./tok.	UD_Catalan-AnCora, sent./tok.
Train	14,287/459,237	13,123/434,140
Development	1,654/54,220	1,709/58,795
Testing	1,721/54,437	1,846/60,107

Table 2: UD_Spanish-AnCora, sent./tok.: the number of sentences/tokens in the UD Spanish-AnCora treebank; UD_Catalan-AnCora, sent./tok.: the number of sentences/tokens in the UD Catalan-AnCora treebank.



Figure 1: Label frequency in Catalan data.



Figure 2: Label frequency in Spanish data.



Figure 3: An example of ArgM: adv - advcl.

role label distribution (see Table 5).

Adverbial: adv

The Adverbial role is a broad category that corresponds to non-specific adjuncts and can be expressed by the UD syntactic relations *advcl* (Figure 3), *advmod* or *obl*.

Agent: agt

The Agent role is associated with the external causer argument that is expressed as the syntactic subject. In some cases the external argument (arg0) may be expressed as an oblique agent complement, keeping its original Agent role as well. The Agent role can be expressed syntactically as *nsubj, det* (Figure 4), *nmod*, and *obl* (Figure 5).

Attribute: atr

The Attribute role refers to the third position (arg2) position in the state-attributive LSS that is typically expressed as the direct object. Other examples that can be found in the data are *root* (Figure 6) and *advcl* (Figure 7)



Figure 4: An example of Arg0: agt - det.



Figure 5: An example of Arg0:agt - obl.

Beneficiary: ben

The Beneficiary role refers to the third argument (arg2) in the ditransitive-patient-benefactive LSS that is syntactically expressed as the indirect object.

Cause: cau

The Cause role is a part of the transitive-causative LSS. Transitive-causative verbs associate the external causer argument (x) with the semantic predicate cause and the internal participant that undergoes the change with the argument (y). The argument x corresponds to the Cause role; It is syntactically the subject.

The Cause role can also take an adjunct position. In that case it receives *obl* or *advcl* (Figure 9) labels.

Cotheme: cot

The Cotheme role refers to the third argument position (arg2) in the ditransitive-theme-cotheme LSS or the unaccusative-cotheme LSS. This role is expressed as a prepositional object – *nmod* or *obl* syntactic labels.

Destination: des

The Destination role typically corresponds to the fifth argument position (arg4) that is most frequently expressed as *obl* and *nmod*.

Experiencer: exp

In inergative-experiencer LSS, the Experiencer role refers to the first argument (arg0) that is expressed as the subject.

When the Experiencer role is a part of the stateexperiencer LSS, it refers to the third argument



Figure 6: An example of Arg2:atr-root.



Figure 7: An example of Arg2:atr-advcl.

(arg2). In this case it is expressed as the indirect object syntactically (Figure 10).

Final State: efi

The Final State role refers to the third argument position (arg2) in the transitive-causative-state LSS or the unaccusative-state LSS. Arg2 can be expressed as an adjunct, a prepositional object or a predicative complement (Figure 11).

Initial State: ein

The Initial State role is similar to the Final State role with the difference that it occurs in the data less frequently. It refers to the third argument position (arg2) in the transitive-causative-state LSS or the unaccusative-state LSS. Arg2 can be expressed as an adjunct, a prepositional object or a predicative complement.

Instrument: ins

The Instrument role refers to the third argument position (arg2) in the transitive-causativeinstrumental LSS (Figure 12)

Location: loc

The Location role can occur in multiple LSS. However, in all of them, the Location role can be expressed as the third argument (arg2), typically a prepositional object or an adjunct (Figure 13) on the syntax level. Except for the ditransitive-themelocative LSS, where this role can be expressed only as an adjunct.



Figure 8: An example of Arg2:ben - iobj.



Figure 9: An example of ArgM: cau - advcl.

In the ditransitive-patient-locative and the unaccusative-passive-ditransitive LSS, the semantic interpretation of Location is bound to a physical location in space. In the unaccusative-motion LSS the semantic interpretation of this role signifies a more specific destination or origin.

Manner: mnr

The Manner role refers to an adjunct (ArgM) that can receive one of the following syntactic labels: *obl* or *advmod* (Figure 14).

Origin: ori

The Origin role occurs in the data less frequently; It marks the place of origin and typically takes the fourth argument position (arg3). The most frequent syntactic label is *obl*.

Patient: pat

In the transitive-agentive-patient LSS and the ditransitive-agentive group of LSS, the Patient refers to the second argument position (arg1) that is expressed as the direct object. The Patient role refers to the second argument position (arg1) in the unaccusative-passive-ditransitive LSS and the unaccusative-passive-transitive. In both cases it is expressed as the syntactic subject.

Purpose: fin

The Purpose role refers to an adjunct; most frequently it is expressed as *advcl* on the syntactic level (Figure 15).

Source: src

The Source role refers to the first argument position (arg0) in the inergative-source LSS (Figure 16).



Figure 10: An example of Arg2:exp-iobj.



Figure 11: An example of Arg2:efi-obl.

Theme: tem

The Theme role can occur in multiple LSS. In the transitive-causative group of LSS, the Theme role takes the second argument position (arg1). In the transitive-agentive LSS group, the Theme role also takes the second argument position (arg1), but its syntactic function is always as a prepositional object with the exception of the ditransitivetheme-cotheme LSS where its syntactic function is as the direct object. If the Theme role occurs in the state-attributive group of LSS, it refers to the second argument (arg1) that is syntactically the subject. When the Theme role occurs in the unaccusative-motion group of LSS as the second argument (arg1), it refers to the syntactic subject. If the Theme role refers to the third argument, it can be expressed as a prepositional object or an adjunct on the syntactic level. The Theme role most frequently receives one of the following syntactic labels: nsubj, csubj, obj, nmod, and obl.

Time: tmp

The Time role refers to temporal adjuncts that most frequently receive the following syntactic labels: *obl, advmod,* and *advcl.*

Empty label: argL

The argL label refers to lexicalized arguments of light verbs. This label does not receive any role label and most frequently occurs as *obl* or *obj* (Figure 17) on the syntactic level.



Figure 12: An example of Arg2: ins - obl.



Figure 13: An example of ArgM: loc - nmod.

4 Functional Generative Description

4.1 Overview

Functional Generative Description (FGD) was introduced by Sgall (1967) in the beginning of 60's and has been gradually developed since then. FGD represents a dependency-based generative description that is based on a multilayer design reflecting the relation of form and function. Continuing the tradition of Prague School, special attention is paid to the phenomenon of topic–focus articulation.

FGD is a stratificational grammar formalism that treats the sentence as a system of interlinked layers:

- phonetic
- phonological
- morphemic
- analytical (surface syntax)
- tectogrammatical (deep syntax)

FGD is focused on the higher layers of the language description, from the morphemic one through the analytical to the tectogrammatical (deep-syntactic) layer that is considered the primary focus (Sgall et al., 1986).

The tectogrammatical representation describes the meaning of the sentence, thus synonymous sentences have a single representation on this level, while an ambiguous sentence has more than one tectogrammatical representation. The tectogrammatical layer contains complete information on the sentence required for its transduction on the lower layers.

Each sentence is represented as a dependency tree with labeled nodes and edges. Nodes represent the meaning units of the sentence containing their lexical and (deep) morphological information. Nodes in an FGD graph are ordered, which helps to capture the information structure of the



Figure 14: An example of ArgM:mnr – advmod.



Figure 15: An example of ArgM: fin - advcl.

sentence (topic-focus articulation). Edges stand for (deep) syntactic relations between the relevant nodes (Petkevič, 1995; Sgall et al., 1986). Deepsyntactic relations (functors) are linked to the valency lexicon which specifies which of the roles constitute the valency frame of the verb (being either obligatory or optional).

FGD serves as a basis for the Prague Dependency Treebank (Hajič et al., 2006; Bejček et al., 2013) and its successors such as Prague Czech-English Dependency Treebank (Hajič et al., 2012), the PDT of Spoken Czech (Mikulová et al., 2017) and the Czech-English Parallel Corpus (Bojar et al., 2011; Mareček, 2011).

In other existing resources that adopted the PDT annotation scheme, the tectogrammatical layer does not seem available, with the exception of the Index Thomisticus treebank of Latin (Passarotti, 2014), whose deep-syntactic annotation is close to PDT.

4.2 Available data

The Prague Dependency Treebank (PDT) is a treebank consisting of a subset of the Czech National Corpus. Its domain is mainly newspaper texts and business and popular scientific articles from the 1990s. The deep-syntactic annotation is available in the PDT from version 2.0 onward (Hajič et al., 2006).

The Prague Czech-English Dependency Treebank (PCEDT) is a manually annotated parallel, aligned treebank that contains the Wall Street Journal text collection of the Penn Treebank. The English part of PCEDT 2.0 contains the entire Penn Treebank – Wall Street Journal Section. The Czech



Figure 16: An example of Arg0:src-nmod.



Figure 17: An example of ArgL: - obj.

part consists of Czech translations of all of the Penn Treebank-WSJ texts. The corpus is 1:1 sentencealigned. An additional automatic alignment on the node level (different for each annotation layer) is available as well (Hajič et al., 2012).

As mentioned in Section 2, this proposal is oriented towards UD. For that reason, the Czech-PDT UD treebank was used to study the data. The Czech-PDT UD treebank is based on the Prague Dependency Treebank 3.0 (PDT). Although the original semantic role labels (functors) are not available in the UD data, it was possible to automatically transfer them from the original PDT data using a Python script.⁷ The same method was applied to the UD version of the Prague Czech-English Dependency Treebank (PCEDT)⁸ (Figure 18).

Table 3 shows the number of sentences and tokens for each corpus.

Table 4 shows 67 semantic role labels (functors)⁹ that were found in the P(CE)DT data and their frequencies

4.3 Semantic Role Labels

Semantic roles (functors) are divided into arguments and adjuncts according to both semantic and formal criteria specified within the valency theory (Panevová, 1974).

FGD specifies five argument roles that correspond mostly to the surface-syntactic slots of a subject and of direct and indirect objects of the verb.

ACT argument: actor

ADDR argument: addressee

EFF argument: effect

ORIG argument: origo

PAT argument: patient

Other types of verbal modifications are considered adjuncts. These functors corresponds to temporal, locational, manner and other kinds of adverbials. They can be classified by their intended purpose.

Functors for the effective roots of independent clauses: express the independence of the given lexical unit and determine the clause type.

DENOM independent nominal

PAR parenthetic clause

PARTL independent interjection

PRED independent verbal clause

VOCAT independent vocative

Temporal functors express various temporal points or intervals that the content of a governing modification relates to. Individual temporal functors differ according to which of the possible questions about time they answer.

TFHL adjunct: for how long

TFRWH adjunct: from when

THL adjunct: (after) how long

THO adjunct: how often

TOWH adjunct: to when

TPAR adjunct: in parallel with what

TSIN adjunct: since when

TTILL adjunct: until when

TWHEN adjunct: when

Locative and directional functors express location or direction related to the content of the governing word. The individual functors differ according to the kind of question they answer.

⁷The original PDT functors will be available in the Czech-PDT UD treebank starting from v2.12.

⁸Access to the UD version of the PCEDT data is restricted due to licensing restrictions. The original Prague Czech-English Dependency Treebank is available in the LDC catalog.

⁹Three extra labels were found in PCEDT: NE (named entity): 37,369, DESCR (adnominal description): 4,077, and SM: 508. However, they were not mentioned in the original PDT guidelines (Mikulová et al., 2006).



Figure 18: Propagation of effective dependencies to a shared argument of coordinate verbs. The sentence is *The spokeswoman said asbestos was used in the 1950s and replaced in 1956.* Note that the auxiliary *was* occurs only once but is included in anchoring of two nodes.

Set	UD_Czech-PDT, sent./tok.	UD_English-PCEDT, sent./tok.
Train	38,725/672,065	39,832/950,028
Development	5,228/90,813	6,960/167,054
Testing	5,475/95,758	2,416/56,684

Table 3: UD_Czech-PDT, sent./tok.: the number of sentences/tokens in the UD Czech-PDT treebank (only the part that has tectogrammatical annotation is counted); UD_English-PCEDT, sent./tok.: the number of sentences/tokens in the UD English-PCEDT treebank.

DIR1 adjunct: where from

DIR2 adjunct: which way

DIR3 adjunct: where to

LOC adjunct: where

Functors for causal relations express various implicational (causal) relations between events or states. The choice of the functor reflects the type of the relation between these two events or phenomena (cause, condition, purpose, or concession etc.)

AIM adjunct: purpose

CAUS adjunct: cause

CNCS adjunct: concession

COND adjunct: condition

INTT adjunct: intention

Functors for expressing manner constitute a broad category of adjuncts that express all kinds of inner characteristics of events – the manner in which the event (state) proceeds/comes about. For

instance, by comparison, by specifying the result or instrument used for accomplishing the event, by expressing quantity etc.

ACMP adjunct: accompaniment

CPR adjunct: comparison

CRIT adjunct: criterion

DIFF adjunct: difference

EXT adjunct: extent

MANN adjunct: manner

MEANS adjunct: means

REG adjunct: with regard to

RESL adjunct: result

RESTR adjunct: exception, restriction

The **COMPL** functor is assigned to predicative complements (i.e. optional adjuncts with a dual semantic relation).

The **CM** functor is a functor assigned to conjunction modifiers, mostly various particles and adverbs.

Functors for specific modifications are assigned to certain specific modifications that are not traditionally included in the syntactic descriptions. These functors could belong to the group of functors for manner and its specific variants.

BEN adjunct: benefactor

CONTRD adjunct: confrontation

HER adjunct: inheritance

SUBS adjunct: substitution

Specific adnominal functors are designed exclusively for modifying (semantic) nouns. The verbal functors only are not sufficient for representing all the functions of adnominal modifications.

APP adnominal adjunct: appurtenance

AUTH adnominal adjunct: author

ID adnominal specification of identity

MAT adnominal argument: content

RSTR adnominal adjunct: modification

Functors for rhematizers, sentence, linking and modal adverbial expressions are designed for representing free modifications and their function in the sentence – to rhematize, to link the sentence to its preceding context or to express various modal meanings and attitude.

ATT speaker's attitude

INTF expletive subject

MOD some modal expressions

PREC preceding context

RHEM rhematizer

Functors for multi-word lexical units and foreign-language expressions are used for representing certain multi-word lexical units or foreignlanguage parts that are not strictly analyzed.

CPHR nominal part of complex predicate

DPHR dependent part of idiom

FPHR part of foreign expression

Functors expressing the relations between the members of paratactic structures do not comply with the general definition of a functor as a semantic value of the syntactic relation of dependency. They do not express a kind of dependency; they rather capture the relation between members of paratactic structures (either clauses or modifications).

ADVS parataxis: adversative APPS parataxis: apposition CONFR parataxis: confrontation CONJ parataxis: conjunction CONTRA parataxis: conflict CSQ parataxis: consequence DISJ parataxis: disjunction GRAD parataxis: gradation OPER parataxis: math operation REAS parataxis: cause

A limited group of functors can be further subclassified using subfunctors. Subfunctors describe semantic variation within a particular functor, typically these differences are expressed by various prepositional phrases, by using different cases or conjuctions.

Subfunctors are not included in this research – this level of granularity goes against the goal of creating a unified set of semantic role labels.

5 Universal Semantic Role Labels

The proposed set of unified semantic labels consists of 14 labels. A unified semantic role label is structured as follows *MAIN:subcategory*.

The main label expresses the main semantic category. Some of the labels do not hold any semantic value, they rather capture the relation between members of paratactic structures or other units. Although the approach does not lean towards a valency dictionary, the distinction between arguments and adjuncts is preserved.

The sub-categorical part of the label is not obligatory. It is designed for preserving original semantic information that may be available in the data.

Arguments

As for the argument labels, the original FGD approach is preserved, with the intention to assign an identical deep representation to an active and passive diathesis of the same predicate.

ACT - corresponds to the ACT functor, the Agent role label **agt** (Section 3.3), the Cause role label **cau** (Section 3.3) when it is associated with the subject (Section 3.3), and the Experiencer role label **exp** (Section 3.3). This label can have the following subcategories:

ACT:agt ACT:cau ACT:exp

ADDR - refers to the Addressee of an event

EFF - refers to the result of the event

ORIG - refers to the origin/source of an event; corresponds to the ORIG functor, and can be extended as **ORIG:src**. The extension corresponds to the Source role label **src** (Section 3.3)

PAT - corresponds to the PAT functor, the Patient role label **pat** (Section 3.3), the Theme role label **tem** (Section 3.3) when it is expressed as arg1. This label can have the following subcategories:

PAT:theme

PAT:atr that corresponds to the Attribute role label **atr** (Section 3.3)

Manner: MANR

The **MANR** label refers to adjuncts of manner that describe how the action, experience, or process of an event is carried out. This label combines the functors for expressing manner, the functors for specific modifications, the Manner role label **mnr** (Section 3.3), and the Beneficiary role label **ben** (Section 3.3) enabling the following combinations if the additional information is available:

MANR:acmp MANR:cpr MANR:crit MANR:diff MANR:ext **MANR:mann** - corresponds to the MANN functor and the mnr role label

MANR:means

MANR:reg

MANR:resl

MANR:restr

MANR:ben - corresponds to the BENN functor and the ben role label ¹⁰

MANR:contrd

MANR:her

MANR:subs

Locative: LOC

The **LOC** label is bound to location or direction. This label combines the Locative and directional functors, the Location role label **loc** (Section 3.3), the Destination role label **des** (Section 3.3), and the Origin role label **ori** (Section 3.3) enabling the following combinations if the additional information is available:

LOC:dir1

LOC:dir2

LOC:dir3 - corresponds to the DIR3 functor and the des role label

LOC:where - corresponds to the LOC functor

textbfLOC:ori - corresponds to the ori role label

Causal: CAUSE

The CAUSE label refers to adjuncts that express various causal relations. It includes various functors from the causal group, the Cause role label **cau** (Section 3.3) when it takes an adjunct position, and the Purpose label **fin** (Section 3.3).

CAUSE:aim - corresponds to the AIM functor and the fin role label

CAUSE:caus - corresponds to the CAUS functor and the cau role label

¹⁰There might be language-specific cases when it would be difficult to distinguish between the Benefactor and Addressee roles.

CAUSE:cncs

CAUSE:cond

CAUSE:intt

Temporal: TIME

The **TIME** label refers to temporal adjuncts that express various temporal points or intervals. This label combines the Temporal group of functors and the Time role label **tmp** (Section 3.3) enabling the following combinations if the additional information is available:

TIME:fhl

TIME:frwh

TIME:hl

TIME:ho

TIME:owh

TIME:par

TIME:sin

TIME:till

TIME:when

Paratactic: BINDER

The **BINDER** label refers to paratactic structures and captures the relation between different parts of the utterance.

BINDER:advs **ADNOM:**auth **BINDER:**apps ADNOM:id **BINDER:**confr **ADNOM:mat BINDER:conj** ADNOM:restr **BINDER:contra Miscellaneous: MISCLL** The MISCLL label is designed for miscellaneous **BINDER:csq** relations. It combines two groups of functors: BINDER:disj the functors for rhematizers, sentence, linking and modal adverbial expressions and the functors for **BINDER:**grad multi-word lexical units and foreign-language expressions. **BINDER:**oper **MISCLL:**att **BINDER:**reas MISCLL:cm

MISCLL:cphr

Independent Clauses: IND

The **IND** label is designed for the functors that express the independence of the given lexical unit and determine the clause type.

IND:denom IND:par IND:partl IND:pred IND:vocat

PCOMPL:compl

Predicative complement: PCOMPL

The **PCOMPL** label is designed for adjuncts that are expressed as predicative complements.

This label combines the COMPL functors, the Final State role **efi** (Section 3.3), and the Initial State role **ein** (Section 3.3) enabling the following combinations if the additional information is available:

PCOMPL:efi PCOMPL:ein Adnominal: ADNOM Since there is no counterpart for this case in the MTT AnCora label sat, the ADNOM label is designed for functors that are assigned to modifications exclusively modifying (semantic) nouns. MISCLL:dphr MISCLL:fphr MISCLL:intf MISCLL:mod MISCLL:prec MISCLL:rhem

6 Conclusion

We have surveyed the label inventories of deepsyntactic relations from two theories and annotation frameworks: Meaning-Text Theory and Functional Generative Description. Based on the observations, we proposed a unified relation inventory, which contains unified labels for relations that are similar or equivalent in the two frameworks, and additional labels for relations that are unique, so that annotations can be mapped with minimal information loss. The unified inventory is hierarchical so that less-specific relation types can be mapped and the missing finer distinctions do not have to be guessed.

In the future, we intend to add mapping from other annotation schemes, such as Sequoia or Prop-Bank. It is possible that the universal relation set will have to be slightly modified as a result; however, the two current source frameworks (and in particular FGD) have quite detailed inventories of relations, therefore we believe that the proposed universal set already covers a substantial part of what can be found in deep-syntactic datasets in general.

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A Appendix: Semantic role label frequency in the PDT and PCEDT data.

Table 4: Semantic role label frequency in the PDTand PCEDT data.

Label	Czech	English
RSTR	142,509	161,142
ACT	94,644	127,884
PAT	89,248	127,173
PRED	50,472	53,352
APP	29,807	32,446
CONJ	24,640	22,536
LOC	21,980	23,804
TWHEN	19,336	25,723
RHEM	12,320	10,104
MANN	9,784	7,587
EXT	8,302	11,564
EFF	7,704	21,044
ADDR	6,761	8,323
PREC	6,126	5,697
DIR3	6,075	4,455
DENOM	5,877	1,296
ID	5,808	1,971
BEN	5,540	3,801
MAT	5,210	5,047
DIR1	4,927	3,766
APPS	4,461	10,284
FPHR	4,192	2,484

Table 4:	Semantic role label frequency in the PDT
	and PCEDT data. (Continued)

and PCEDT data. (Continued)			
PAR	4,191	3,124	
ACMP	3,780	3,404	
REG	3,165	12,211	
СМ	2,958	1,248	
MEANS	2,870	2,215	
CPHR	2,707	3,138	
CAUS	2,612	3,293	
COND	2,525	2,101	
CRIT	2, 485	1,464	
AIM	2,415	4,991	
THL	2,105	2,582	
ADVS	2,048	2,105	
ATT	2,026	1,587	
MOD	1,770	738	
COMPL	1,558	3,522	
OPER	1,538	984	
THO	1,401	1,935	
DPHR	1,263	896	
DISJ	1,254	1,947	
TTILL	1,219	1,212	
ORIG	1,095	3,617	
DIFF	931	5,007	
TSIN	924	962	
CPR	885	2,532	
AUTH	774	449	
CNCS	753	1,056	
RESTR	738	744	
GRAD	709	226	
TPAR	608	1,514	
CSQ	470	205	
DIR2	447	296	
RESL	399	641	
TFHL	375	1,300	
SUBS	303	321	
REAS	243	68	
INTT	189	127	
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and TEEDT data. (Continued)		
TOWH	185	153
CONTRD	168	547
CONTRA	168	56
TFRWH	166	431
INTF	126	8
PARTL	102	106
VOCAT	60	31
HER	33	13
CONFR	23	75

Table 4: Semantic role label frequency in the PDT
and PCEDT data. (Continued)

B Appendix: Thematic role label frequency in the AnCora data.

Label	Spanish	Catalan	Associated arg position
Patient: pat	29922	24039	arg1
Agent: agt	24951	18432	arg0
Theme: tem	23628	18318	arg1, arg2, arg3
Attribute: atr	11864	10616	arg2, argM, arg3
Time: tmp	10674	9014	argM
Location: loc	9406	8057	argM, arg2, arg1, arg3
Adverbial: adv	9852	6581	argM
Cause: cau	3627	2726	argM, arg0
Beneficiary: ben	3027	2112	arg2, arg3
Purpose: fin	2203	1788	argM, arg2
Manner: mnr	1945	1669	argM
Final State: efi	684	596	arg2, arg4
Destination: des	862	523	arg4
Empty label: "	725	511	argL
Extension: ext	725	472	arg2, argM, arg1
Cotheme: cot	148	251	arg2, arg1
Origin: ori	386	198	arg3
Experiencer: exp	174	125	arg2, arg3, arg0
Initial State: ein	112	109	arg3, arg2
Instrument: ins	88	36	arg2
Source: src	30	4	arg0

Table 5