Towards 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 and PropBank. The research is based on the data from four Indo-European and one Uralic language – Spanish and Catalan (Taule et al., 2011), Czech (Hajič et al., 2017), English (Hajič et al., 2012), and Finnish (Haverinen et al., 2015). Updated datasets with the new universal semantic role labels are now publicly available as a result of our work. Nevertheless, our proposal is oriented towards Universal Dependencies (UD) (de Marneffe et al., 2021) and our ultimate goal is to apply a subset of the universal labels to the full UD data.

Keywords: Semantics, Deep representation, Language resource

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’, ‘textogrammatical’, or even ‘semantic’. Unfortunately, the annotations in this layer have not reached the level of cross-linguistic uniformity and interoperability as 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 have selected the approaches that have been extensively studied for a longer period of time, and have been utilized in natural language applications, such as Meaning-Text Theory (Kahane, 2003), Functional Generative Description frameworks (Sgall, 1967) and PropBank (Kingsbury and Palmer, 2002). We study the inventories used in these 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 in order to annotate semantic roles on top of UD. Only a few coarse and cross-linguistically applicable valency frames (superframes) are defined in CRANS in order to avoid reliance on large-coverage, language-specific valency dictionaries.

We first survey the deep-syntactic relations in Meaning-Text Theory (Section 2), Functional Generative Description (Section 3), and PropBank (Section 4).2 We provide a comparison of the

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1 https://universaldependencies.org/

2 Our approach was rather opportunistic: We were able to find data for the selected frameworks. This is also the reason why our current language pool is not too varied typologically (there are four Indo-European and one Uralic language). One could ask, for example, what would happen if we worked with an ergative language. We assume that the necessary inventory of semantic roles will not change much (if at all), but their mapping to syntax can be quite different of course.
frameworks (Section 5). Finally, in Section 6 we propose a unified set of relations to which the other three can be mapped.

2. Meaning-Text Theory

2.1. 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). MTT defines a seven-level representation that describes the relation between form and meaning. The set of deep-syntactic relations used in MTT consists of numbered arguments and “utility” relations such as ATTR for attributes and other modifiers, COORD for coordination, and APPEND for parentheses, interjections, and other similar items.

2.2. Thematic Roles

The AnCora corpus of Catalan and Spanish (Taulé et al., 2008) 3 was used to examine the set of semantic relations defined in MTT. Deep syntactic / semantic relations are assigned to up to seven argument slots (arg0, arg1, arg2, arg3, arg4, argM, and argL) and 20 thematic roles. Each of the roles can be mapped to several syntactic functions and argument positions. The arguments required by the verb sense are incrementally numbered, expressing their degree of proximity in relation to its predicate (Palmer et al., 2005). The two unnumbered argument slots are argM for adjuncts and argL for lexicalized complements of light verbs.

2.2.1. 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, advmod or obl.

2.2.2. 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, nmod, and obl as in El gol fue convertido por Rodrigo Barra “The goal was scored by Rodrigo Barra”.

2.2.3. Attribute: atr

The Attribute role refers to the third position (arg2). It is typically expressed as the direct object. Other examples that can be found in the data are ccomp and root (Figure 1).

2.2.4. Beneficiary: ben

The Beneficiary role refers to the third argument (arg2). In UD it is expressed as obl as in Esto permitirá al banco sanear su portafolio “This will allow the bank to clean up its portfolio”.

2.2.5. Cause: cau

The Cause role corresponds to the external causer argument that is typically the syntactic subject. The Cause role can also take an adjunct position. In that case it receives the UD labels obl or advcl as in Me gusta este trabajo, porque aquí hay mucho por hacer “I like this job because there is a lot to do here”.

2.2.6. Cotheme: cot

The Cotheme role refers to the third argument position (arg2). This role is expressed as a prepositional object — the UD labels nmod or obl as in El viaducto peatonal conecta Mollet con Martorell “The pedestrian viaduct connects Mollet with Martorell”.

2.2.7. Destination: des

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

2.2.8. Experiencer: exp

The Experiencer role refers to the first argument (arg0) that is expressed as the subject. In some cases it can correspond to the third argument (arg2) that is expressed as the UD label obl.

2.2.9. Final State: efi

The Final State role refers to the third argument position (arg2). It can be expressed as a predicative complement or a prepositional object — the UD label obl as in Ni siquiera ha llegado a sietemesino “Not even has reached seven months”.

2.2.10. 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) and can be expressed as a prepositional object or a predicative complement as in *El que la derriba, ha ido de la insatisfacción a la violencia.* “The one who tears it down has gone from dissatisfaction to violence.”

2.2.11. Instrument: ins
The Instrument role refers to the third argument position (arg2) that is typically expressed as obl in UD as in *Los policías, equipados con material antidisturbios, se mantendrán atentos a posibles incidentes* “The police, equipped with riot gear, will remain alert to possible incidents”.

2.2.12. Location: loc
The Location role can be expressed as the third argument (arg2) marked with the UD labels obl or obl:arg.

2.2.13. Manner: mnr
The Manner role refers to an adjunct (argM) that can receive one of the following syntactic labels: obl or advmod.

2.2.14. 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.

2.2.15. Patient: pat
The Patient refers to the second argument position (arg1) that is typically expressed as the direct object. It can also be expressed as the syntactic subject as in *Cualquiera que lo hiciese con más jugadores relevándolos habitualmente era considerado como un loco* “Anyone who did it with more players relieving them was usually considered crazy”.

2.2.16. Purpose: fin
The Purpose role refers to an adjunct; most frequently it is expressed as advcl on the syntactic level as in *Para entendermos, diríamos esesperpentos* “To understand each other, we would say grotesque”.

2.2.17. Source: src
The Source role refers to the first argument position (arg0) represented by the UD label nmod as in *La catedral padeció una oleada de pintadas* “The cathedral suffered a wave of graffiti”.

2.2.18. Theme: tem
The Theme role typically takes the second argument position (arg1). Most frequently it receives one of the following syntactic labels: nsubj, obj, nmod, and obl.

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

2.2.20. Empty label: argL
The argL slot refers to the lexicalized arguments of light verbs. This slot does not receive any role label and most frequently occurs as obl or obj (Figure 2) on the syntactic level.

![Figure 2: The desire to show off. An example of ArgL: obj.](image)

Figure 2: *The desire to show off.* An example of *ArgL:* obj. The idiomatic light verb construction *darse aires* (lit. give oneself air) means “to brag, to show off.”

3. Functional Generative Description

3.1. Overview

Functional Generative Description (FGD) represents a dependency-based generative description that is based on a multilayer design reflecting the relation of form and function (Sgall, 1967). Deep syntactic information is captured by the tectogrammatical representation that describes the meaning of the sentence. Thus synonymous sentences have a single representation at this level, while an ambiguous sentence has more than one tectogrammatical representation.

3.2. Semantic Role Labels

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 original semantic role labels (functors) have been carried over to the UD data. The same conversion was applied to the Prague Czech-English Dependency Treebank (PCEDT). There are 67 semantic roles (functors), divided into arguments (actants, inner participants) and adjuncts according to both semantic and formal criteria specified within the valency theory (Panevová, 1974).

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4Access to the UD version of PCEDT is restricted due to license terms. The original PCEDT is available through the Linguistic Data Consortium.
3.2.1. Argument Functors
FGD specifies five argument roles that correspond mostly to the core arguments (subject, direct and indirect object) of the verb on the surface-syntactic layer.

Figure 3: Their point is whether you are coming. A non-canonical example where **ACT** is a dative (oblique) argument.

Figure 4: The bank provided cities with money for residents. An example of **ADDR** realized as dative oblique argument, and **BEN** realized as prepositional oblique dependent.

Figure 5: The demand has pushed the price to $5. An example of **EFF** realized as an oblique argument.

**ACT** argument: actor; mostly nsubj, sometimes obl:arg (Figure 3), obl:agent (in passive clauses), or even obl.

**PAT** argument: patient; mostly obj, also nsubj:pass, or even nsubj as in Bolí ho noha “His leg hurts”.

**ADDR** argument: addressee; mostly obl:arg (Figure 4).

Other types of verbal modifications are considered adjuncts. These functors correspond to temporal, locational, manner and other kinds of adverbials. They can be classified by their intended purpose and typically occur as obl, advmod, and nmod in UD.

3.2.2. Locative and Directional Adjuncts
Locative and directional functors express location or direction related to the content of the governing word (see Table 4 for details).

3.2.3. Temporal Adjuncts
Temporal functors express various temporal points or intervals. Individual temporal functors differ according to which of the possible questions about time they answer (see Table 5 for details).

3.2.4. Manner Adjuncts
Functors for expressing manner constitute a broad category of adjuncts that express the inner characteristics of events such as comparison, specifying the result of an event or the manner an action is performed (see Table 2 for details).

3.2.5. Causal Adjuncts
Functors for causal relations express various causal relations between events or states such as cause, condition, purpose, or concession (see Table 3 for details).
3.2.6. Specific Adjuncts
The following functors are assigned to certain specific modifications that are not traditionally included in the syntactic descriptions. They are close to manner adjuncts (see Table 2 for details).

3.2.7. Adnominal Functors
Specific adnominal functors are designed exclusively for modifying (semantic) nouns (see Table 8 for details).

3.2.8. Rhematizer Functors
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 (see Table 9 for details).

3.2.9. Functors for Multi-word Lexical Units
This group of functors is used for representing certain multi-word lexical units or foreign-language parts that are not strictly analyzed (see Table 9 for details).

3.2.10. Paratactic Structures
This group of functors expresses the relations between the members of paratactic structures (either clauses or modifications) (see Table 7 for details).

3.2.11. Independent Clauses
Functors for the effective roots of independent clauses express the independence of the given lexical unit and determine the clause type (see Table 6 for details).

3.2.12. Other Functors
The COMPL functor is assigned to predicative complements. The CM functor is assigned to conjunction modifiers, mostly various particles and adverbs.

4. PropBank

4.1. Overview
The Proposition Bank project focuses on the argument structure of verbs, including roles traditionally viewed as either arguments or adjuncts, adding a layer of predicate-argument information, or semantic role labels, to the constituent structures in the Penn Treebank (Palmer et al., 2005).

4.2. Semantic Labels
To broaden the typological variability of our research, we have included (in addition to English) the Finnish Proposition Bank (Haverinen et al., 2015). It is built on top of the Turku Dependency Treebank.6

The English PropBank frames were propagated from the Penn Treebank (Marcus et al., 1993) constituent trees to their UD conversion.7 The PropBank defines semantic roles on a verb-by-verb basis. An individual verb’s semantic arguments are numbered, beginning with 0 and ending with 5. ARG0 is generally the argument exhibiting features of a Prototypical Agent (Dowty, 1991), while ARG1 is a Prototypical Patient or Theme. No consistent generalizations can be made across verbs for the higher-numbered arguments, though an effort has been made to consistently define roles across members of VerbNet classes (Palmer et al., 2005).

- ARG0: mostly nsubj
- ARG1: mostly obj, nsubj; in English also ccomp: Mr. Spielvogel said he hopes that ...
- ARG2: mostly obl, root5 in the Finnish data; in English also obl
- ARG3, ARG4, ARG5: mostly obl; in Finnish also advmod
- ARG: used for a causal agent, only with verbs of volitional motion as in He followed offers with threats.
- ARGM: used for adjuncts, whose meaning is not tightly bound to a particular verb.

PropBank also uses a number of subtypes that further specify the function or semantic category of a participant. They can extend the main label, as in ARGM-LOC. They are most often seen with adjuncts (ARGM), but they can also extend the numbered arguments, and some are even more frequent with numbered arguments than with adjuncts (e.g., ARG1-PRD or ARG2-EXT). The Finnish data differs from English more in the usage of subtypes than in other aspects.

- LOC: location; mostly obl
- DIR: direction; mostly obl, in English also compound, case
- TMP: time; mostly obl, advmod
- MNR: manner; mostly advmod, obl
- CAU: cause; mostly advcl, obl
- PNC: purpose; mostly obl, advcl
- ADV: other adverbial; mostly advmod, obl
- EXT: extent; mostly obl, in Finnish also advmod
- PRD: for secondary predication; mostly obl, in English also xcomp


5UD conversion of PCEDT was used.
6For compatibility reasons, the treebank was converted from UD v1 to UD v2 using UDPipe 2.

7In copula constructions.

8Purpose clauses are marked with PRP in the English data and with PNC in the Finnish data.
• **REC**: reciprocal; mostly **advmod**
• **MOD**: modal verb; mostly **aux**
• **NEG**: negation marker; mostly **aux** in the Finnish data, and **advmod** in English
• **DIS**: discourse connectives, such as **still**, **also**, however, but, for example; mostly **advmod**, in Finnish also **obl**
• **CSQ**: consequence; only Finnish, mostly **acl:relcl**
• **PRF**: phrasal marker; only Finnish, mostly **obl**, **compound**

5. Comparison of the Frameworks

We will now present some observations on the similarities and divergencies across the three frameworks introduced above. The comparison will serve as the basis for our proposal of a unified taxonomy in Section 6.

PDT defines functors for all content words in the sentence, including modifiers of nominals. AnCora and PropBank define them only for participants of events; they can be nominals and not necessarily verbs, but they must denote events.

5.1. Inner Participants

We do not have space to assess all labels here due to their high number, especially on the PDT side. Therefore we will concentrate on the most important ones, namely the five arguments (‘inner participants’).

**Actor, agent** The PDT label **ACT** and the AnCora label **arg0:agt** have very similar meanings but they are not identical. **ACT** is defined relatively as the most active participant; it does not have to be too active if there are no other participants. So it includes experiencers, which have a separate label in AnCora: **arg0:exp**. It even includes inanimate subjects in change-state clauses (Las reservas de oro subieron 800 millones de dólares “Gold reserves rose by $800 million”), which AnCora labels as themes (**arg1:tem**). Causer in causative constructions is **arg0:cau** in AnCora but **ACT** in PDT (but note that there are also subordinate clauses of cause, which are **argM:cau** in AnCora and **CAUS** in PDT).

In PropBank, **ARG0** typically corresponds to AnCora’s **arg0:agt**. Similar reservations hold between PropBank and PDT as between AnCora and PDT. In **The door opened**, the door is **ACT** in PDT but **ARG1** in PropBank because the opening was caused by some unexpressed agent. This contrasts with the passive sentence **The door was opened**, where both PDT and PropBank regard the subject as **PAT** / **ARG1**. In certain causative frames, PropBank’s **ARGA** is AnCora’s **arg0:cau**.

**Patient** The PDT label **PAT** is the participant affected by the action, and the second most prominent one; if a predicate has only two arguments, the less active of the two will be **PAT**. It is most likely to correspond to **arg1:pat** in AnCora; however, with predicates where the object is more abstract, it may be labeled **arg1:tem** (cubrir empleos en diversos sectores “to fill jobs in various sectors”).

In the majority of cases the PropBank label **ARG1** corresponds to the PDT label **PAT**; but sometimes it maps to **ACT** (see above) or to **EFF** (see below). PDT **PAT** is also used for secondary predication, as in *His client contacts could prove a gold mine*; such cases are labeled **ARG2-PRD** in PropBank.

**Addressee** The PDT label **ADDR** is the addressee or recipient in events of giving and transfer. In these events, the addressee slot is licensed by the verb and is thus treated as inner participant. In contrast, almost every event can have an adjunct expressing beneficiary. It gets a different label, **BEN** (Figures 4 and 7). AnCora does not seem to make the distinction. It uses **arg2:ben** in both cases.

The PropBank label **ARG2** typically corresponds to the PDT label **ADDR**, as in *Sallalle osaan kylää neuleen kuvitella* “For Salla, I can certainly imagine the sweater.” **ARG2-EXT** primarily corresponds to the broader PDT labels of **DIFF**, **EXT**, and **REG**, which express manner by specifying differences between the compared events, by indicating the extent or intensity of the event, and by saying with respect to what something holds. Furthermore, we mentioned above that **ARG2-PRD** would be **PAT** in PDT.

**Effect** The PDT label **EFF** denotes the result of an event. While it is licensed by the verb and thus inner participant, it is usually not obligatory. A frequent example is changed value, as in *Poptávké zvedla ceny stříbra až na 5,5 dolarů za trojskou unci* “The demand pushed silver prices up to $5.50 per troy ounce” (Figure 5); similar examples in AnCora are labeled **arg4:des** (destination). On the other hand, the destination role in AnCora also applies to directional adjuncts in movement events, which would be labeled **DIR3** in PDT. PDT also uses **EFF** in events that are not changes of state in the true sense: *být považován za vůdčí osobnost* “to be considered a leading figure”. In AnCora, such an argument would be **arg2:atr** (attribute).

While any generalization about PropBank’s **ARG3** to **ARG5** has to be taken with a grain of salt, many instances of **ARG3** and **ARG4** correspond to **EFF** in PDT, e.g., *The union, though, has called the offer “insulting”*. In some cases **ARG1** may correspond to **EFF** as in *GM officials said they, too, were surprised by the move.*

**Origo** The PDT label **ORIG** is the least frequent of the five argument functors. While it may cor-
respond to the English preposition from, it is not used for adjuncts of direction (those would get DIR1) or time (those would get TFRWH or TSIN). Being licensed by the verb, it is used, e.g., for material from which something is made, and also when distinguishing or separating something from something else: *Od Evropy nás dělí velký kus cesty* “A long way separates us from Europe” (Figure 6). Similar examples in AnCora are annotated as arg2:cot (cotheme). In contrast, the seemingly corresponding label arg3:ori is used for directional and temporal adjuncts.

In PropBank, similar constituents are higher-numbered arguments. A relatively frequent example is ARG3-from as in to change its emphasis from buying mortgage loans.

### 5.2. Adjuncts and PropBank-specific Subtypes

About a half of the PDT functors (32) classify adverbial adjuncts. In AnCora and PropBank, adjuncts are the subtypes of argM / ARGM. Many of them are self-explanatory and can be mapped easily, the only problem being different levels of granularity in the three frameworks. We highlight some interesting cases here. Recall that PropBank subtypes, although generally intended for ARGM, sometimes occur with numbered arguments and some of them are even more likely to accompany a numbered argument than ARGM.

ARGM-EXT usually corresponds to the PDT label PAT as in *Aetna closed at $60*.

The PropBank label PRD is designed for secondary predicate and typically used as a subtype of arguments (rather than adjuncts). It corresponds to multiple argument labels in PDT such as PAT as in *Many of the morning-session winners turned out to be losers* by afternoon, and EFF as in *It was just the culture of the industry that kept it from happening*.

The discourse connective label ARGM-DIS within PropBank conforms to the PDT labels PREC (a functor linking the clause to the preceding context) and RHEM, which represents a rhematizer, including negative expressions. Negative expressions are distinguished by ARGM-NEG in PropBank.

The PropBank label MOD is used for modal verbs as in *The notes can be redeemed*. It differs from the PDT label MOD, which represents modal adverbs or particles: *Maybe Mr. Z. was too busy*. Modal verbs in PDT are treated as attributes of the main verbs and do not receive their own functors. The PropBank label CAUS is used for causative constructions such as *Tuota tekiisi mieli sovittaa, sillä vartalon tarvitsee aivan tietyn mallisen mekon* “I would like to fit that, because my body needs a dress of a very specific model”. This label directly corresponds to the CAUS label in PDT.

The purpose clauses labeled as PNC in the Finnish data or PRP in the English data correspond to PDT functors indicating causal relations. The majority of cases match the PDT label AIM as in *Sinne ne sitten jäävät kurottelemaan tavoliteilaan* “That’s where they stay to reach their goals”. Some cases correspond to BEN as in Mr. Achenbaum will do some strategic consulting at the agency for *non-clients* or CAUS as in *Procardia, a heart medicine, have shrunk because of increased competition*.

The PropBank label REC is used for reciprocity as in *Both men seemed to work well together*. In PDT, reciprocity is represented on the tectogrammatical layer by inserting a node with the #Rcp t-lemma in the position of the omitted valency slot. This means that there is no separate PDT functor for reciprocals; instead, the node has the functor corresponding to the unoccupied valency position (PAT in the majority of cases).

### 6. Unified Semantic Role Labels

Our goal is to define a label set capable of capturing as many distinctions from the source frameworks as possible. The role classification has to be hierarchical so that less granular source labels can be mapped to less specific labels (higher level in the hierarchy). The proposed set consists of 13 top-level labels. A unified semantic role label is structured as follows: MAIN:subcategory. Figure 8 shows an example sentence annotated with unified semantic role labels.

The MAIN label expresses the main semantic category. Some FGD-motivated labels step out of the line and classify paratactic relations or other phenomena. The subcategory part is optional. It is designed for preserving finer distinctions that are available in some frameworks. For instance, the LOC label (Table 4) is intended for denoting location or direction. P(CE)DT and AnCora have the capability to distinguish between specific categories within the direction category. In this case, this information can be preserved and a sub label can be assigned (LOC:dir1, LOC:dir2 or LOC:dir3). PropBank has a single label for direction, so only the coarse grained LOC label can be assigned.

As a practical result, the datasets for the five languages discussed in the paper are accessible at [http://hdl.handle.net/11234/1-5474](http://hdl.handle.net/11234/1-5474).
The datasets provide unified labels to enhance interoperability and support cross-lingual studies.

6.1. Arguments

Although the approach does not lean towards a valency dictionary, we loosely follow the PDT distinction between arguments and adjuncts (Table 1) keeping in mind that it will not be precise due to varying definitions of arguments and adjuncts across frameworks.

<table>
<thead>
<tr>
<th>Label</th>
<th>Sublabel</th>
<th>P(CE)DT</th>
<th>AnCora</th>
<th>PropBank</th>
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<tr>
<td>ACT</td>
<td>AGT</td>
<td>AGT</td>
<td>ARG0</td>
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<td>ACT</td>
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<td>EXP</td>
<td>ARGO</td>
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<td>ADDR:adrs</td>
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<td>ARG3</td>
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<td>ORIG:or</td>
<td>ORIG:or</td>
<td>ARG3-from</td>
<td>ARG3-from</td>
</tr>
</tbody>
</table>

Table 1: Arguments

6.2. Manner: MANR

The MANR label refers to adjuncts of manner that describe how the action, experience, or process of an event is carried out (Table 2).

<table>
<thead>
<tr>
<th>Label</th>
<th>Meaning</th>
<th>P(CE)DT</th>
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<th>PropBank</th>
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<td>ARGMr</td>
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<td>N/A</td>
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<td>DIFF</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>MANR:constr</td>
<td>contrast</td>
<td>CONTR</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
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<td>substitution</td>
<td>SUBS</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>MANR:res</td>
<td>result</td>
<td>RESL</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>MANR:cmp</td>
<td>comparison</td>
<td>CPR</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>MANR:acmp</td>
<td>accompaniment</td>
<td>ACMP</td>
<td>N/A</td>
<td>ARGMA-DV</td>
</tr>
<tr>
<td>MANR:benef</td>
<td>benefactor</td>
<td>BEN</td>
<td>ARGMb</td>
<td>ARGMb</td>
</tr>
<tr>
<td>MANR:her</td>
<td>inheritance</td>
<td>HER</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>MANR:crit</td>
<td>criterion</td>
<td>CRIT</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>MANR:reg</td>
<td>regarding</td>
<td>REG</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>MANR:compl</td>
<td>pred. complement</td>
<td>COMPL</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 2: MANR Role

6.3. Causal: CAUSE

The CAUSE label refers to adjuncts that express various causal relations (Table 3). Note that there are two additional causal relations that are paratactic and thus clustered with the BINDER roles (Section 6.7): reas and csq.

<table>
<thead>
<tr>
<th>Label</th>
<th>Meaning</th>
<th>P(CE)DT</th>
<th>AnCora</th>
<th>PropBank</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAUSE:aim</td>
<td>purpose</td>
<td>AIM</td>
<td>ARGMin</td>
<td>ARGMin</td>
</tr>
<tr>
<td>CAUSE:int</td>
<td>intension</td>
<td>INTT</td>
<td>ARG2-P</td>
<td>ARG2-P</td>
</tr>
<tr>
<td>CAUSE:caus</td>
<td>cause</td>
<td>CAUS</td>
<td>ARGMc</td>
<td>ARGMCau</td>
</tr>
<tr>
<td>CAUSE:conc</td>
<td>concession</td>
<td>CNCS</td>
<td>ARGMadv</td>
<td>ARGMCau</td>
</tr>
<tr>
<td>CAUSE:cond</td>
<td>condition</td>
<td>COND</td>
<td>-</td>
<td>ARGMA-DV</td>
</tr>
</tbody>
</table>

Table 3: CAUSE Role

6.4. Locative: LOC

The LOC label is bound to location or direction (Table 4).

<table>
<thead>
<tr>
<th>Label</th>
<th>Meaning</th>
<th>P(CE)DT</th>
<th>AnCora</th>
<th>PropBank</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOC:where</td>
<td>where</td>
<td>LOC</td>
<td>argMloc</td>
<td>ARGMLoc</td>
</tr>
<tr>
<td>LOC:dir1</td>
<td>from dir</td>
<td>DIR1</td>
<td>argMori</td>
<td>ARGMMori</td>
</tr>
<tr>
<td>LOC:dir2</td>
<td>which dir</td>
<td>DIR2</td>
<td>argMloc</td>
<td>ARGMLoc</td>
</tr>
<tr>
<td>LOC:dir3</td>
<td>to dir</td>
<td>DIR3</td>
<td>argMdes</td>
<td>ARGMDIR</td>
</tr>
</tbody>
</table>

Table 4: LOC Role

6.5. Temporal: TIME

The TIME label refers to temporal adjuncts that express various temporal points or intervals.

<table>
<thead>
<tr>
<th>Label</th>
<th>Meaning</th>
<th>P(CE)DT</th>
<th>AnCora</th>
<th>PropBank</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME:when</td>
<td>when</td>
<td>WHEN</td>
<td>TSIN</td>
<td>TPSIN</td>
</tr>
<tr>
<td>TIME:frwh</td>
<td>from when</td>
<td>FRWH</td>
<td>TFRWH</td>
<td>TFRWH</td>
</tr>
<tr>
<td>TIME:since</td>
<td>since when</td>
<td>SIN</td>
<td>SIN</td>
<td>SIN</td>
</tr>
<tr>
<td>TIME:par</td>
<td>in parallel with</td>
<td>PAR</td>
<td>TPAR</td>
<td>TPAR</td>
</tr>
<tr>
<td>TIME:for</td>
<td>for how long</td>
<td>FOR</td>
<td>TFHLM</td>
<td>TFHLM</td>
</tr>
<tr>
<td>TIME:to</td>
<td>to when</td>
<td>TOH</td>
<td>TOH</td>
<td>TOH</td>
</tr>
<tr>
<td>TIME:until</td>
<td>until when</td>
<td>UNTIL</td>
<td>UNTIL</td>
<td>UNTIL</td>
</tr>
<tr>
<td>TIME:how</td>
<td>how often</td>
<td>HOW</td>
<td>THO</td>
<td>THO</td>
</tr>
</tbody>
</table>

Table 5: TIME Role

6.6. 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 (Table 6).

<table>
<thead>
<tr>
<th>Label</th>
<th>Meaning</th>
<th>P(CE)DT</th>
<th>AnCora</th>
<th>PropBank</th>
</tr>
</thead>
<tbody>
<tr>
<td>IND:pred</td>
<td>independent clause</td>
<td>PRED</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>IND:par</td>
<td>parenthetic clause</td>
<td>PAR</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>IND:nom</td>
<td>independent nominal</td>
<td>NOM</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>IND:vocat</td>
<td>vocative</td>
<td>VOCAT</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>IND:partl</td>
<td>independent interjection</td>
<td>PARTL</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 6: IND Role

6.7. Paratactic: BINDER

The BINDER label refers to paratactic structures and captures the relation between different parts of the utterance (Table 7).

6.8. Adnominal: ADNOM

The ADNOM label is designed for modifiers of (semantic) nouns (Table 8). This is needed for PDT functors but there is no counterpart in AnCora and PropBank.

6.9. Miscellaneous: MISCLL

The MISCLL label is designed for miscellaneous relations such as rhematizers, linking and modal adverbial expressions (Table 9).

7. Conclusion

We have surveyed the label inventories of deep-syntactic relations from three annotation frameworks: Meaning-Text Theory, Functional Generative Description and PropBank. Based on these
observations, we propose a unified relation inventory, which contains unified labels for relations that are similar or equivalent in the three 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.

As a result, the five languages discussed in the paper can be queried using the unified set of semantic role labels. Our future plans involve the application of this label set to all UD treebanks. We intend to combine cross-lingual projection (as in the Universal PropBank project) with heuristics that will use the surface syntax as input (and with valency frame lexicons if available). In any case, such an annotation is destined to contain noise. But with the unified label set, we can at least provide comparable annotation for datasets where it has to be estimated automatically, and for those where it can be obtained from dedicated deep syntactic/semantic resources.

Our semantic labels are applicable to enhanced as well as basic relations, and we intend to apply them to enhanced graphs in future work. However, the current dataset is based on basic trees, which are available for all UD languages. The three 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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8. Bibliographical References


9. Language Resource References