SynSemClass for German: Extending a Multilingual Verb Lexicon

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Abstract. We present the concept of extending a multilingual verb lexicon also to include German. In this lexicon, verbs are grouped by meaning and by semantic properties (following frame semantics) to form multilingual classes, linking Czech and English verbs. Entries are further linked to external lexical resources like VerbNet and PropBank. In this paper, we present our plan also to include German verbs, by experimenting with word alignments to obtain candidates linked to existing English entries, and identify possible approaches to obtain semantic role information. In addition, we identify German-specific lexical resources to link to. This small-scale pilot study aims to provide a blueprint for extending a lexical resource with a new language.

Keywords: Linked Lexicon · Semantics · Synonymy · Parallel Corpus

1 Introduction

In Natural Language Processing (NLP), lexical resources play an important role for supporting a computer's understanding of human language. Such machine-readable resources not only list lexical surface forms, but often also provide additional syntactic and semantic properties, focusing on particular word groups [10, 33, 38], use cases [9], or languages other than English[3] [13, 27, 42]. While recent neural technologies have proven to be very successful at a number of NLP tasks learning from unannotated data only (i. e., without using any form of explicitly encoded knowledge external to the language data itself) [8, 26, 28], these approaches rely on the availability of large amounts of data, which may not always be available for the desired language or domain. Additionally, certain semantic properties may not be sufficiently picked up on by a system trained on large amounts of unannotated data only [4, 45]. Moreover, such systems are, by design, sensitive to bias in the training data [36, 3].

This paper focuses on a verb lexicon in which synonym classes are defined in terms of both semantic and syntactic properties. Computational verb lexicons,

[3] Which is, for many paradigms and tasks, the most popular language in NLP research and Language Technology applications [29, 30].

such as VerbNet, have proven to be useful in supporting a wide range of NLP tasks and applications, including information extraction [21], sentence similarity [41] and event extraction [44]. With regard to the use of VerbNet for event extraction, a new release of the lexicon [5] includes a modified version of the semantic representation of verbs to provide an improved representation of event and subevent structures in language.[4] Unlike the majority of monolingual verb lexicons, a multilingual aligned verb lexicon supports deeper understanding and comparability of the usage of verbs in different languages, and simultaneously provides a close interaction between syntactic and semantic features of verbs. Additionally, a multilingual resource of this kind is able to provide a broader range of applications, among others, cross-lingual search.

In this paper, we outline our plans to extend an existing, bi-lingual (Czech and English) verb lexicon in which verbs are grouped into synonym classes both meaning-wise (verb senses, semantic roles) and structurally (valency arguments). To ease adaptation and increase compatibility with existing resources, verb classes and individual entries are linked to existing lexical resources where possible. The existing lexicon is described in [39] and we outline our plans to both validate this lexicon and its classes and extend it to include a subset of German verbs as well. To demonstrate our plans, we perform a small-scale pilot study enabling us to test the outcome and reliably estimate the time and resources needed for the extension plan.

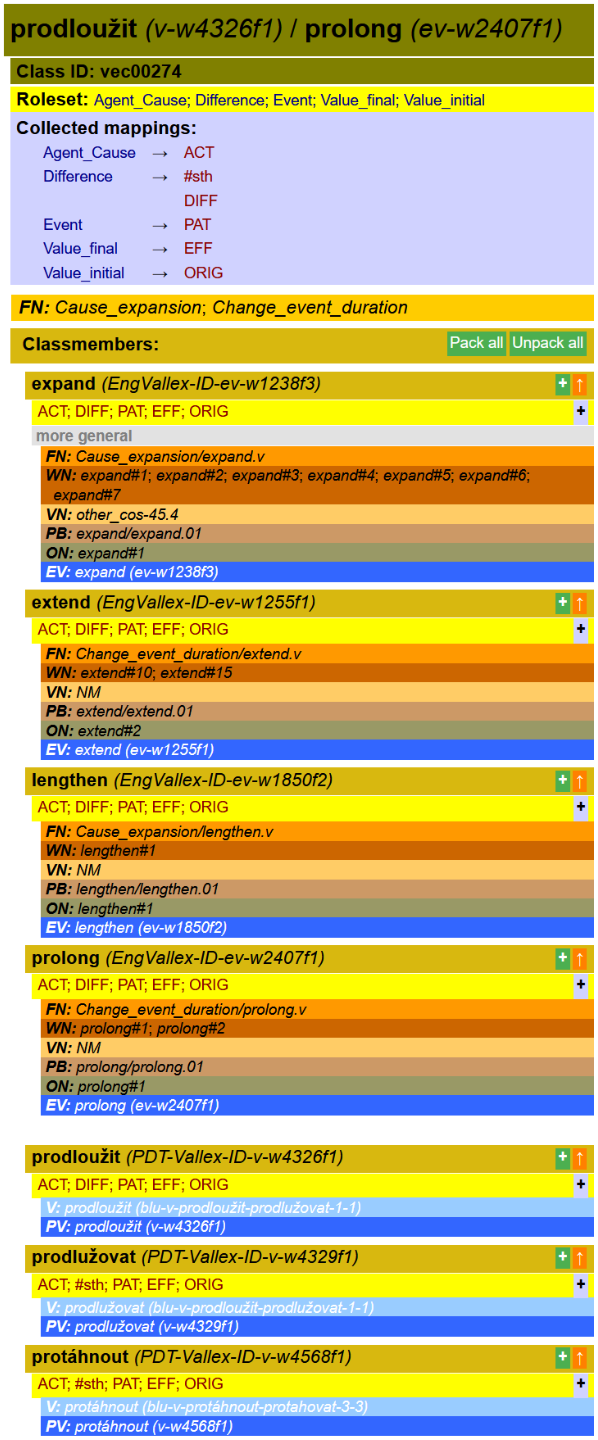
We first provide a brief description of the existing, bi-lingual lexicon and its key properties (Section 2). Then, we explain the corpus we use for the pilot study (Section 3), followed by the procedure to extract word alignments (Section 4.1) and semantic role properties (Section 4.2) including a description of the resources we link to (Section 5). Finally, Section 6 sums up our key findings and provides an outlook on the full-scale study we intend to perform as future work.

2 SynSemClass

The SynSemClass lexicon currently[5] groups Czech and English verbs by meaning and structural properties. It contains 145 synonym classes with 3,515 Czech and English verb senses; 2,027 in English and 1,488 in Czech. Each class is assigned a set of semantic roles and the prototypical meaning of the synonym class representing the English and Czech verb sense. The lexicon was developed in a bottom-up fashion. Class member candidates originate from actual corpus examples (the Prague Czech-English Dependency Treebank [12]), starting off with 200 semi-randomly chosen Czech verbs (and their valency information, coming from the monolingual PDT-Vallex [40]), and going from Czech to English and vice versa, with manual adjudication steps in between. There is no specific

[4] Event detection is our main use case, see, e. g., [32], [22], [31].

[5] At the time of writing; a new version, SynSemClass3.0, with 455 classes containing approx. 3,800 verbs on each side was published at the end of December 2020, see http://hdl.handle.net/11234/1-3439.



prodloužit *(v-w4326f1)* / **prolong** *(ev-w2407f1)*

Class ID: vec00274

Roleset: Agent_Cause; Difference; Event; Value_final; Value_initial

Collected mappings:

Agent_Cause	→	ACT
Difference	→	#sth DIFF
Event	→	PAT
Value_final	→	EFF
Value_initial	→	ORIG

FN: *Cause_expansion; Change_event_duration*

Classmembers:

expand *(EngVallex-ID-ev-w1238f3)*

ACT; DIFF; PAT; EFF; ORIG

more general

FN: *Cause_expansion/expand.v*
WN: *expand#1; expand#2; expand#3; expand#4; expand#5; expand#6; expand#7*
VN: *other_cos-45.4*
PB: *expand/expand.01*
ON: *expand#1*
EV: *expand (ev-w1238f3)*

extend *(EngVallex-ID-ev-w1255f1)*

ACT; DIFF; PAT; EFF; ORIG

FN: *Change_event_duration/extend.v*
WN: *extend#10; extend#15*
VN: *NM*
PB: *extend/extend.01*
ON: *extend#2*
EV: *extend (ev-w1255f1)*

lengthen *(EngVallex-ID-ev-w1850f2)*

ACT; DIFF; PAT; EFF; ORIG

FN: *Cause_expansion/lengthen.v*
WN: *lengthen#1*
VN: *NM*
PB: *lengthen/lengthen.01*
ON: *lengthen#1*
EV: *lengthen (ev-w1850f2)*

prolong *(EngVallex-ID-ev-w2407f1)*

ACT; DIFF; PAT; EFF; ORIG

FN: *Change_event_duration/prolong.v*
WN: *prolong#1; prolong#2*
VN: *NM*
PB: *prolong/prolong.01*
ON: *prolong#1*
EV: *prolong (ev-w2407f1)*

prodloužit *(PDT-Vallex-ID-v-w4326f1)*

ACT; DIFF; PAT; EFF; ORIG

V: *prodloužit (blu-v-prodloužit-prodlužovat-1-1)*
PV: *prodloužit (v-w4326f1)*

prodlužovat *(PDT-Vallex-ID-v-w4329f1)*

ACT; #sth; PAT; EFF; ORIG

V: *prodlužovat (blu-v-prodloužit-prodlužovat-1-1)*
PV: *prodlužovat (v-w4329f1)*

protáhnout *(PDT-Vallex-ID-v-w4568f1)*

ACT; #sth; PAT; EFF; ORIG

V: *protáhnout (blu-v-protáhnout-protahovat-3-3)*
PV: *protáhnout (v-w4568f1)*

Fig. 1. SynSemClass entry for *p*rolong/prodloužit synonym class in online browser

model or lexicographic theory behind it, even though the underlying syntactic-semantic lexicons for Czech and English (PDT-Vallex and EngVallex), which provide the (current) sense distinctions, are based on the Functional Generative Description theory [35]. The notion of synonymy used is based on the “loose” definition of synonymy by Lyons and Jackson [18, 15], or alternatively and very closely, on both “near-synonyms” and “partial synonyms” as defined by Lyons [19, 7] or “plesionyms” as defined by Cruse [6]. The SynSemClass lexicon is also available online.[6] For more details on its creation process as well as inter-annotator agreement numbers see [39]. An example of a current SynSemClass class entry for (*prolong/prodloužit*) is depicted in Fig. 1.

In the following sections, we describe our plans to expand this bi-lingual lexicon to German, based on the preliminary results of a pilot study.

3 Corpus

The original lexicon was created from a bi-lingual and (automatically) word-aligned corpus, based on a part of the Penn Treebank [20] manually translated into Czech by a professional translator. The Czech sentences were automatically processed to annotate them with morphological information and dependency parses. To maintain this data-driven basis of the original lexicon linking Czech and English verbs on the basis of their usage in a corpus, we thus need either a parallel Czech-German corpus or a parallel English-German corpus.

After settling upon a sentence-aligned parallel corpus, word alignments need to be extracted to establish links between either English or Czech verbs on the source side and German verbs on the target side. Because German is typologically closer to English than to Czech (German and English are West-Germanic languages, Czech is a Slavic language), we expect word alignment tools, exploiting syntactic information, to perform better on an English-German parallel corpus. A large number of candidate corpora are listed in the OPUS corpus browser[7]. Because several of these originate from a particular domain (European Parliament meeting transcripts [16], movie subtitles [17] or Wikipedia [43]), but SynSemClass verbs are not tuned to any particular domain or genre, we simply select the largest resource (which also does not seem to be targeted at one particular domain or genre), i. e., ParaCrawl[8]. The English-German part of ParaCrawl contains over 82 million parallel sentences, with 1.5 billion tokens on the German and 1.6 billion tokens on the English side.

[6] https://lindat.mff.cuni.cz/services/SynSemClass

[7] http://opus.nlpl.eu

[8] https://paracrawl.eu

4 Method

4.1 Word Alignments

For the extraction of word alignments we use MGIZA [23]. Our small scale pilot study is based on the first 5 million sentences of the EN-DE ParaCrawl corpus, containing approx. 94 million German and approx. 98 million English tokens.

Further narrowing the scope of our pilot study, we select the canonical forms of the English classes starting with *a* in SynSemClass, i. e., the following 13 verbs: *agree*, *allow*, *announce*, *applaud*, *approach*, *approve*, *arise*, *arrest*, *assert*, *assume*, *attend*, *avoid*, *await*. For each we automatically extract the most frequent alignments with a cut-off of 0.2%, meaning that if the particular English verb was aligned to a particular German word or phrase in more than 0.2% of cases (in English) it was selected and discarded otherwise. This list was then manually checked by one of the authors of this paper in order to eliminate the many irrelevant entries among the automatically extracted list. Examples are verb/noun ambiguity (at this point, we only had word alignments, no part-of-speech-tag information yet), such as for *approach*, which was aligned to the German *ansatz* (*approach*, but only in the noun sense) in 28% of cases, and to *nähern* (*approach* in the verb sense) in 24% of cases. Another frequent reason for filtering out automatically extracted alignments was the co-extraction of pronouns (*erlauben* ***es***, *allow* ***it***) or particles (***zu*** *genehmigen*, ***to*** *approve*), where the actual verb was among the list already. For some relatively infrequent verbs (such as *applaud*, occurring only 65 times (in infinitival form) in our 5 million sentence subset of the corpus, compared to 3,448 for *agree* or 10,989 for *allow* (again, counting infinitival forms only), some obviously non-sensical alignments still made it past the 0.2% threshold, such as *spielen ihre rolle bis grenzen möglichen mithin spendest beifall* ("*play their role to the limits possible therefore give applause*") for *applaud*.

After manually processing the automatically extracted alignment list, we were left with 100 German root forms of verbs as candidate entries (7.7 verbs per seed verb on average, with the most alignments (16) for *approve* and *arise*, and the least alignments (3) for *await*). The next step is to obtain more structural and semantic information for these candidate entries.

4.2 Semantic Role Labeling

In addition to meaning, the semantic roles that a class can assign are important for the clustering of verbs in SynSemClass. In the creation of the Czech-English lexicon, the semantic roles (SRs) are "mostly taken from FrameNet" [39, p. 13]. The German equivalent, the collaborative *FrameNet des Deutschen*[9], does not specify SRs, but does link to the original FrameNet [2], and SR information could be retrieved from there, in the same way this was done for the Czech-English SynSemClass lexicon. This will be consulted with the SynSemClass entries in the future, in order to keep a common set of roles for each class.

[9] https://gsw.phil.hhu.de/framenet/frameindex

Alternatively, the 2009 CoNLL shared task included SR labeling for seven different languages (including German), inspiring many automated approaches [11]. More recently, inspired by transformer architectures and their multilingual capabilities, there have been attempts at contributing to the SR labeling task using neural approaches [14, 37]. Such automated procedures support a more data-driven specification of the SRs of particular verbs and are able to specify this information for verbs that occur in the corpus (which, in our case, is rather large). Their downside is the expected quality of the output; [14] report F_1-scores ranging from 81.41 for German and 91.00 for English, demonstrating that at least for German, such automatic SR labeling systems still have a considerable margin of error. Manually curated resources such as FrameNet (and its German equivalent) are likely to provide better quality for the verbs they cover, but obviously will not help us for verbs not included in the lexical resource.

For our study, we searched our 100 root forms of German verbs in *FrameNet des Deutschen*. Because these are sometimes described using the verb (e. g., for "besuchen"[10]) and sometimes using the corresponding noun (e. g., for "Verhaftung"[11]), we made sure that the search string would match both the verb and corresponding noun. The German FrameNet contains 834 entries, and only 23 of our 100 verbs were found in this way. For these entries, we can thus obtain SR information through the link to the English FrameNet entry. For the remaining 77 entries, however, we must resort to other means of getting SR information. We consider the approach of [14], who made their code publicly available, a promising start for processing sentences containing verbs that are not included yet in the German FrameNet. Given their F_1-score, which is impressive but still leaves considerable room for improvement, the output can be manually checked for individual entries before including them in SynSemClass as German verbs.

5 Linking to Existing Resources

The original SynSemClass lexicon is linked to a range of resources (see Section 3.2 in [39]), including popular resources like FrameNet [2], VerbNet [34] and PropBank [24]. By linking the new German entries to the existing classes in SynSemClass, we thus establish a link between our German verbs and, among others, VerbNet entries. As for German-specific resources, we consider linking to *FrameNet des Deutschen* an important way of connecting SynSemClass to existing lexical resources for German. Additional resources we consider linking to are 1) GermaNet [13], a lexical resource for German that contains nouns, verbs and adjectives and groups them by synsets and defines relations between these synsets in the WordNet tradition, and 2) Universal Proposition Banks [1][12], which provides a list of German verbs annotated with frame and role labels linked to the English Proposition Bank (PropBank) [25]. Furthermore, we

[10] https://gsw.phil.hhu.de/framenet/frame?id=441
[11] https://gsw.phil.hhu.de/framenet/frame?id=499
[12] https://github.com/System-T/UniversalPropositions

plan to explore if meaningful links to resources available in the Linguistic Linked Open Data cloud (LLOD) can be established.

Such links between SynSemClasses with German verbs in them and existing German resources will probably have to be established manually; the German FrameNet has an intuitive search interface that we also used in Section 4.2.

6 Conclusion

This paper presents our plan to expand a bi-lingual (Czech and English) lexicon of verbs to a multilingual verb lexicon by including German verbs. The existing SynSemClass lexicon groups verbs by their meaning and by semantic role properties and links them internally (Czech and English) and externally (to existing resources such as FrameNet, VerbNet and PropBank). To expand the lexicon to include German verbs, we thus need 1) correspondences between German verbs and their English and Czech counterparts, and 2) SR information for the German verbs. We plan to obtain this using 1) word alignments extracted from a parallel English-German corpus, and 2) exploiting existing German resources (*FrameNet des Deutschen*) in combination with recent advances in automatic semantic role labeling approaches. We executed a small-scale pilot study using 5 million of the 82 million aligned sentences in a candidate corpus, and using only 13 entries from SynSemClass. This allows us to estimate the time and resources required to perform the full-scale exercise.

Extracting word alignments from a parallel corpus (for which we use MGIZA) is a time-consuming process, but mostly takes compute time (over 50 hours on a single laptop (i7 2.20Ghz, 24GB RAM), but we estimate that at least half of this can be optimised through parallelisation. Manual filtering of irrelevant alignments for our 13 pilot verbs took approx. one hour. We do note that in the creation process of the SynSemClass lexicon, the authors went back and forth between Czech and English in three steps [39, p. 13] (Figure 2), to find more alignment candidates. In our pilot study we only perform the first step, which already expands the seed size of 13 English verbs to a list of 100 German candidates (after filtering). Including more alignment steps will thus further increase the size of the candidate set, but by a smaller factor (i. e., we expect additional alignment steps to increase by a factor considerably smaller than 7.7).

Collecting the semantic role information was done completely manually in our pilot study and took ca. 0.5 hours, but resulted in this information for only 23% of the entries. We did not yet experiment with automatic approaches to semantic role labeling. This procedure will take relatively cheap compute processing time; the amount of time and effort needed to manually amend results before the entries can be included in SynSemClass remains to be seen.

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