Zero Alignment of Verb Arguments in a Parallel Treebank

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Abstract

This paper analyses several points of interlingual dependency mismatch on the material of a parallel Czech-English dependency treebank. Particularly, the points of alignment mismatch between the valency frame arguments of the corresponding verbs are observed and described. The attention is drawn to the question whether such mismatches stem from the inherent semantic properties of the individual languages, or from the character of the used linguistic theory. Comments are made on the possible shifts in meaning. The authors use the findings to make predictions about possible machine translation implementation of the data.

1 Introduction

In Machine translation tasks lately, paraphrases have been used and studied intensely. They basically serve to improve the evaluation metrics of MT systems. The ability to generate valid paraphrases also plays an important role in information retrieval tasks, textual entailment etc. The so-called paraphrase tables can be automatically extracted from parallel corpora (Denkowski and Lavie, 2010; Ganitkevitch et al., 2013).

So far, only lexical paraphrases have been explored for Czech (Baraněková et al., 2014), with syntactic (structural) paraphrases intended for future enhancement of the systems. For English, experiments with both lexical and syntactic paraphrases are employed (Dorr et al., 2004).

This paper presents a preliminary linguistic analysis of structural paraphrases based on valency representations. It appears that certain types of paraphrases affect the valency structure of verbs, and possibly the semantic structure of the sentence, in terms of foregrounding or backgrounding different arguments.¹

We believe that the analysis of possible syntactic variation within paraphrases, especially such that involves a kind of “disproportion”, in the parallel treebank data, would be beneficial for further MT experiments.

By a disproportion in dependencies, we mean such structural configurations that involve different number of dependencies in corresponding syntactic structures, i.e., an alignment of “something” on one side of the translation to “nothing” on the other side. For the purposes of this paper, we call it a “zero alignment”.

2 Related Work

The analysis in this paper goes in a similar direction as that of (Sanguinetti et al., 2013), though our interest in what they call a “translation shift” is of a different kind. The authors claim that dependency structures are finely apt to account for the alignment of syntactically different treelets between languages, because of the subtree structures constituting similar semantic units. We take their findings as our starting point and provide a linguistic analysis of some of the well-identified categories of translation shift from their research, in order to get a better understanding of different linguistic grounds for different syntactic structures for a parallel semantic content. Also, our analysis is based on the deep syntactic layer (in contrast to the surface structure alignments used in the paper mentioned above), therefore it does not have to deal with those structural phenomena that might not have important semantic consequences, but only serve for topic-focus hierarchization purposes (such as word order variation, simple passivization etc.).

¹Here, we use the label “argument” in a simplifying manner. Any element which is included in the valency frame is referred to as an argument.
Our research is also inspired by (Bojar et al., 2013), an attempt to generate as many possible translation paraphrases as possible, in order to enlarge the reference set of translations for MT evaluation purposes. The experiment described in the paper used mostly a flat approach, and was carried out with substantial work provided by human annotators. We believe that our research might help establish rules for automatic extraction of true syntactic paraphrases (without unnecessary noise) from parallel corpora, based on the valency patterns of words, so that most of the work could be done automatically, with minimal human control.

3 Methodology and Data

In the research, we took the advantage of the existence of Czech-English parallel data, namely the Prague Czech-English Dependency Treebank 2.5 (PCEDT 2.5) (Hajič et al., 2012).²

It is a collection of about 50,000 sentences, taken from the Wall Street Journal part of Penn treebank (Marcus et al., 1993),³ translated manually to Czech, transformed into dependency trees and annotated at the level of deep syntactic relations (called tectogrammatic layer). In short, the tectogrammatic layer contains mostly content words (with several defined exceptions) connected with oriented edges and labelled with syntactico-semantic functors according to the Functional Generative Description approach (FGD), see (Sgall et al., 1986). Ellipsis and anaphora resolution is also included, as well as automatic alignment of corresponding nodes. The PCEDT 2.5 is annotated according to the FGD valency theory (FGDVT) and two valency lexicons (one for each language) are part of the release.

PDT-Vallex⁴ (Hajič et al., 2003; Urešová, 2011) has been developed as a resource for annotating argument relations in the Prague Dependency Treebank (Hajič et al., 2006). The version used here contains 11,933 valency frames for 7,121 verbs. Each valency frame in the PDT-Vallex represents a distinct verb meaning. Valency frames consist of argument slots represented by tectogrammatic functors (slots). Each slot is marked as obligatory or facultative and its typical morphological realization forms are listed. Frame entries are supplemented with illustrative sentence examples.

EngVallex⁵ (Cinková, 2006) was created as an adaptation of an already existing resource of English verb argument structure characteristics, the Propbank (Palmer et al., 2005). The original Propbank argument structure frames have been adapted to the FGD scheme, so that it currently bears the structure of the PDT-Vallex, though some minor deflections from the original scheme have been allowed in order to save some important theoretical features of the original Propbank annotation. This lexicon includes 7,148 valency frames for 4,337 verbs.

PDT-Vallex and EngVallex have been interlinked together into a new resource called CzEngVallex (Urešová et al., 2015a; Urešová et al., 2015). Beside the complete data of the two lexicons, the CzEngVallex contains a database of frame-to-frame, and subsequently, argument-to-argument pairs for the purposes of machine translation experiments (Urešová et al., 2015b). PCEDT and the CzEngVallex data have already been used successfully in several MT experiments aimed at valency frame detection and selection (Dušek et al., 2014) and also for word sense disambiguation (Dušek et al., 2015).

The interlinking of CzEngVallex frames was carried out via an annotation over the PCEDT. First, an automatic alignment procedure was run over the data, which suggested translational links between nodes of the tectogrammatic layer. Corresponding verb pairs⁶ and argument pairs were highlighted. Then, manual revision and correction of the alignments by two annotators was carried out. Thus, as a by-product of building the lexicon, a collection of illustrative annotated tree pairs is available for each verb pair of the CzEngVallex.

4 Zero Alignment in the Data

In the following sections, we will describe the most important, consistent and frequent points of zero alignment found in the data. For each section, we will comment on the linguistic background of the phenomena described and the possible consequences for semantic interpretation in the individual languages.

²https://catalog.ldc.upenn.edu/LDC2012T08
³https://catalog.ldc.upenn.edu/LDC99T42
⁴http://lindat.mff.cuni.cz/services/PDT-Vallex
⁵http://lindat.mff.cuni.cz/services/EngVallex
⁶As a basic stage of building the CzEngVallex, only verb-verb pairs were taken into account.
4.1 Catenative Verbs - Single vs. Double Object Interpretation

One of the prominent points of alignment disproportion in the data are sentences with catenative verbs. Catenative verbs are usually defined as those combining with non-finite verbal forms. Between the finite catenative verb and the non-finite verb form, there might appear an intervening NP that might be interpreted as the subject of the dependent verbal form. In this section, we will be concerned with exactly those verbs allowing the sequence of a finite catenative verb – NP – a non-finite catenative verb.

4.1.1 ECM Constructions, Raising to Object

Most Czech linguistic approaches do not recognize the term Exceptional Case Marking (ECM) in the sense of “raising to object”, instead they generally address similar constructions under the label “accusative with infinitive”. The difference between ECM and control verbs is not being taken into account in most of Czech grammars. In short, raising and ECM are generally considered a marginal phenomenon in Czech and are not being treated conceptually (Panevová, 1996), except for several attempts to describe agreement issues, e.g., the morphological behaviour of predicative complements described in a phrase structure grammar formalism (Przepiórkowski and Rosen, 2005).

The reason for this negligent approach to ECM is probably rooted in the low frequency of ECM constructions in Czech. Czech sentences corresponding to English sentences with ECM mostly do not allow catenative constructions. They usually involve a standard dependent clause with a finite verb, see Fig. 1, or they include a nominalization, thus keeping the structures strictly parallel.

The only exception are verbs of perception (see, hear), which usually allow both ways of Czech translation – with an accusative NP followed by a non-finite verb form (1a), or with a dependent clause (1b), not speaking about the third possibility involving an accusative NP followed by a dependent clause (1c).

(1) He saw Peter coming.
   a. Viděl Petra přicházet. He saw Peter.ACC to come.
   b. Viděl, že Petr přichází. He saw that Peter.ACC is coming.
   c. Viděl Petra, jak přichází. He saw Peter.ACC, how is coming.

In this type of accusative-infinitive sequence, the accusative element is in FG/DVT analysed consistently as the direct object of the matrix verb (the PATient argument) and the non-finite verb form then as the predicative complement of the verb (the EFFECT argument).

The PCEDT annotation of verbs of perception is shown in Fig. 2, with frame arguments mapped in the following way:

\[ \text{ACT} \rightarrow \text{ACT}; \ \text{PAT} \rightarrow \text{EFF}; \quad \ldots \rightarrow \text{PAT} \]

The literature mentions two ways of ECM structural analysis, a flat one, representing the NP as dependent on the matrix verb, and a layered one, representing the intervening NP as the subject of the dependent verb. This mirrors the opinion that verbs allowing ECM usually have three syntactic, but only two semantic arguments. It is then a matter of decision between a syntactic and semantic approach to tree construction.

The English part of the PCEDT data was annotated in the layered manner, thus most of the pairs in the treebank appear as strictly parallel. The consistency of structures is one of the most impor-
The verb involved in this kind of translation shift may be either a more remote synonym, or a conversive verb. Such a translation shift brings about (at least a slight) semantic shift in the interpretation, usually in the sense of de-causativisation of the meaning (prompt → lead to). Nevertheless, this type of semantic shift does not prevent the use of the struc-
Figure 3: Alignment of the control verbs’ arguments

4.2 Complex Predication

By “complex predication” we mean a combination of two lexical units, usually a (semantically empty, or “light”) verb and a noun (carrying main lexical meaning and marked with CPHR functor in the data), forming a predicate with a single semantic reference, e.g., to make an announcement, to undertake preparations, to get an order. There are some direct consequences for the syntactically annotated parallel data.

First type of zero alignment is connected to the fact that a complex predication in one language can be easily translated with a one-word reference, and consequently aligned to a one-word predication, in the other language. This is quite a trivial case. In the data, then, one component of the complex predication remains unaligned. There are basically two ways of resolving such cases: either one can align the light verb with the full verb in the other language, or one can align the full verb with the dependent noun in the complex predication, based on the similarity of semantic content. In the CzEngVallex, the decision was to align the verbs, reflecting the fact that the verb and the noun phrase form a single unit from the semantic point of view.

The second type of zero alignment is connected to the presence of a “third” valency argument within the complex predication structure, e.g., En: placed weight on retailing - Cz: klást důraz na prodej, see Fig. 5.

Complex predicates have been annotated according to quite a complicated set of rules on the Czech side of the PCEDT data (for details, see (Mikulová et al., 2006)). Those rules include also the so-called dual function of a valency modification. There are two possible dependency positions for the “third” valency argument of the complex predicate: either it is modelled as the dependent of the semantically empty verb, or as a dependent of the nominal component. The decision between the two positions rely on multiple factors, such as valency structure of the semantically full use of the verb, valency structure of the noun in other contexts, behaviour of synonymous verbs etc. On the Czech side, the “third” valency argument was strongly preferred to be a dependent of the nominal component.

On the English side of the PCEDT, the preferred decision was different. The “third” argument was annotated as a direct dependent of the light verb

En: ...making water run...
Cz: ...přimět vodu téct...

Figure 4: Alignment of English OCV with Czech non-OCV construction
Other furriers have also placed more weight on retailing.

There is probably no chance of dealing with the dependencies in one of the two above stated ways only. The class of complex predicates in the data is wide and heterogeneous with respect to semantic and morphosyntactic qualities. Nevertheless, the data suggest several points of interesting inconsistencies stemming from the imperfection or lack of reliability of the theoretical guidelines. For example, the dependency of the valency complementation of the complex predicate klást důraz ‘place emphasis’, as can be seen in Fig. 5, is solved as a dependency on the nominal component, whereas in the complex predicate klást požadavek ‘place claim’, the valency lexicon entry involves a direct dependency on the verb. Keeping in mind that the verb klást ‘to place’ has three arguments in its semantically full occurrences, we would expect direct dependency on the verb in both cases.

### 4.3 Conversive Verbs

A considerable number of unaligned arguments in the data is caused by the translator’s choice of a verb in a conversive relation to the verb used in the original language. For some reason (e.g., frequency of the verbal lexical unit, topic-focus articulation etc.), the translator decides not to use the syntactically most similar lexical unit, but uses a conversive one (cf. also Sect. 4.1.2), thus causing the arguments to relocate in the deep syntactic structure, see Fig. 6.

En: His election increases Ryder’s board to 14 members.

Cz: Jeho zvolením se počet členů správní rady společnosti Ryder zvýšil na 14.
in case there is no semantic agent in the structure. Thus we get semantically quite different elements (e.g., +anim vs. -anim) in the ACT position, even with formally identical verb instances, see the English side of Figs. 7 and 8.

Figure 7: Conflict due to the underspecification of the ACT position

This formal feature of the FGDVT gives rise to a number of conflicts in the parallel structures considering structures that undergo semantic de-agentization or (milder) de-concretization of the agent.

Here the question arises, whether such verb instances correspond to different meanings of the verb (represented by different verb frames), or whether they correspond to a single meaning (represented by a single valency frame). It is often the case, that the Czech data tend to overgeneralize the valency frames through considering the different instances as realizations of a single deep syntactic valency frame, when there is no other modification intervening in the frame. Therefore, this approach chosen for the Czech annotation sometimes shows a conflict, as in Fig. 7.

The valency structure for both instances of base is identical, only in the first case, the verb is used in active voice, whereas in the second case, it takes passive morphology. There are three semantic arguments in the structure. We will call them the Person that expresses an opinion, the Expressed Opinion and the Resource for the opinion. The Person bases the Expressed Opinion on the Resource. With the English verb, the Expressed Opinion always takes the PAT position and the Resource the ORIGIN position in the valency structure. On the other hand, on the Czech side of the data, there is a conflict. In both cases, there are seemingly only two arguments. In the first case, the Expressed Opinion is sort of backgrounded from the semantic structure. If there were a need of overtizing it, it would probably appear with locative morphology, as an adjunct: Wertheimer se v tomto opírá o prohlášení... ‘Wertheimer in this relies on a statement’ (see also an authentic example from the data in Fig. 9). In the second case, on the other hand, the structure follows the passivized English structure in backgrounding the Person (note that the se morpheme does NOT stand for a passive morphology here). If there were a need for expressing the Person, it would probably appear as a specifying dependent to the ACT position: Jejich zpráva se opírá o telefonický výzkum. ‘Their report is based on a phone survey’. In the second case, the Expressed Opinion does not take the PAT position, but the ACT position in the structure, which is the cause of the conflict. We are able to reformulate the first case
The conflicts in annotation have a substantial reason – the ways in which English and Czech express backgrounding of the agent are multiple and they differ across the languages. Czech uses the \textit{se}-morphemization often, in order to preserve the topic focus articulation (information) structure, whereas English does not have such a morpheme to work with, so it often uses simple passivization, or middle construction.

Moreover, the first valency position in Czech is often overgeneralized, allowing a multitude of semantically different arguments, which is, due to “economy of description”, sometimes not reflected in the linguistic theory.

4.4 ArgumentsMapped to Adjuncts

In the previous section, we have described the bilingual treebank data manifestation of the fact that languages have different means of expressing a content, and we have noted that these can also variate between argument and adjunct interpretation. This variation appears both within a single language (one language expresses a largely synonymous content with either argument or adjunct means) and across languages (a direct consequence of the former case: an argument (actant) in one language can be translated into another language using an adjunct construction). Languages may differ in the preference for either of the possibilities.

Observing such mismatches in a parallel treebank occasionally leads us to hesitate whether our interpretation of a word (or phrase) as an argument or adjunct is proper or justifiable. There may be two possible consequences drawn from the observation of a mismatch – either there are some (rather subtle) semantic reasons for structuring a word as an argument/adjunct, or there might be some imperfection in our theoretical thinking about the internal system of a particular language.

The theoretical distinction between arguments and adjuncts is subject to serious debates in the world of linguistics (Hwang, 2011; Tutunjian and Boland, 2008), and so far there is no approach known to us that would overcome this problem easily. Still, we can see that the real data indicate some remarkable points that stand at the roots of the argument/adjunct distinction problem. Most prominently - the nature of the relation between the form of the argument and its semantics.

In the parallel treebank, we find cases (among
others) such as alignment of an actor with a temporal adjunct (4) or an actor with a causal adjunct (5), etc.

(4) Americans haven’t forgiven China’s leaders for the military assault of June 3–4 that killed hundreds, and perhaps thousands, of demonstrators.

(a) Američané neodpustili čínským vůdcům Americans haven’t forgotten Chinese leaders
vojenský útok z 3–4. června, military assault from 3–4 June,
při kterém zahynuly stovky, možná i during which died hundreds, maybe even
tisíce demonstrantů. thousands demonstrators

(5) The purchase will make Quebecor the second-largest commercial printer in North America.

(a) Díky této koupi se společnost Thanks to this purchase REFL the company Quebecor stane will become druhou největší Quebecor will become second largest komerční tiskárnu v Severní Americe. commercial printer in North America

The interpretation of the argument in the above stated examples is driven mainly by its morphological form, which is a surprising finding considering that we are dealing with deep syntax, or even semantics.

It is believed that the form of the expression more or less mirrors its function in the language. The width of the paraphrasing range though, both within and across languages, leads us to questioning whether it is appropriate to lay much stress on the difference between arguments and adjuncts in the description of a language.

5 Conclusion

We have encountered several reasons for the presence of a zero alignment in the data. Though these reasons have different grounds they tend to be interconnected in the language.

1. Language is flexible in paraphrasing linguistic content with different syntactic means. Even pairs of sentences which include semantic backgrounding or foregrounding of different arguments are easily interpreted as synonymous.

2. It is possible to use predicates that are in a conversive relation, or predicates of different complexity.

3. The backgrounding and foregrounding of arguments leads to syntactic relocation of other arguments in the structure, and consequently to the shift in their morphosyntactic properties, to the shift in their valency status, or even to their complete disappearance from the structure.

4. The FGD, having been built on a morphologically rich Czech language, relies strongly on the morphosyntactic form of the individual arguments. Therefore, disproportions of the zero alignment or argument mismatch kind must appear when it is applied to other languages with different typological properties.

Points 1, 2 and 3 belong among inherent deeply rooted properties of (perhaps any) natural language. Such differences are not to be overcome by means of possible theoretical unification of description.

Point 4, on the other hand, belongs to the properties of a certain linguistic theory. We will leave it open, whether it were appropriate to change the very roots of a linguistic theory in order to make it more flexible for use across different languages. Nevertheless, it appears that it is at least possible to change those aspects that cause individual and otherwise unjustifiable conflicts in the data.

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