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MODELLING VALENCY FRAMES USING INHERITANCE: THE CASE OF CZECH ADJECTIVES *-telný* ‘able’

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Abstract: We introduce a first step to modelling valency frames of selected types of nominals. We work on the assumption that nominals inherit – at least to some extent – valency from their base verbs. We illustrate this task in a case study focused on modelling valency frames of Czech deverbal adjectives *-telný* ‘able’. First, the valency frames of the adjectives *-telný* contained in NomVallex are compared with the valency frames of their base verbs in VALLEX. Based on this comparison, two formal rules describing valency changes in the valency frames of adjectives *-telný* are formulated. Second, for each lexical unit of a verb that satisfies the conditions imposed by some of the rules, the derived adjective *-telný* is extracted from DeriNet, if such an adjective is available. Third, the valency frame of the adjective is derived from the valency frame of the verb based on the respective rule. Lastly, the accuracy of both rules is verified in the corpus data. The experiment has shown that the valency of these adjectives can be modeled on the rule basis. However, if this task is to be accurate, it requires advanced linguistic information, namely the information on semantic class membership of verbs and on compound adjectives.

Keywords: inheritance of valency, deverbal adjectives, valency lexicons, derivational relations, suffixes, Czech

1 INTRODUCTION

Valency, a number and type of complements a verb (or a noun and an adjective) combines with, is a lexicosyntactic property, which is asserted not to be automatically predictable, and as such it has to be described in a lexicon (e.g. Žabokrtský 2005). However, a significant number of words share their valency properties with their base words. For example, the number and type of valency complements of the adjective *obvinitelný* ‘accusable’ are identical to those of its base verb *obviňovat* ‘to accuse’, cf. examples (1) and (2). The same applies to the adjective *polepšitelný*

'corrigible' and its base verb *polepšit se* 'to improve oneself', cf. (3) and (4).[1] Changes occur in the surface expression of adjectival complements, as morphemic forms of some of the complements and the surface ellipsis show.

(1) *obviňovat* 'to accuse': ACT_1^{obl} $ADDR_4^{obl}$ $PAT_{z+2,že}^{obl}$
Otec matku obviňoval z absurdní přecitlivělosti (SYN v13)
'The father accused the mother of absurd hypersensitivity'

(2) *obvinitelný* 'accusable': ACT_7^{obl} $ADDR_{\uparrow}^{obl}$ $PAT_{z+2,že}^{obl}$
matka obvinitelná otcem z absurdní přecitlivělosti
'the mother accusable by the father of absurd hypersensitivity'

(3) *polepšit se* 'to improve oneself': ACT_1^{obl}
Polepší se lidstvo?
'Will humankind improve?'

(4) *polepšitelný* 'corrigible': $ACT_{\uparrow}^{obl}$
Je lidstvo polepšitelné? (SYN v13)
'Is humankind corrigible?'

The fact that deverbal adjectives can inherit valency properties from their base verbs, as illustrated with examples (2) and (4),[2] can be exploited to automatically model their valency frames, the manual annotation of which is both time-consuming and demanding in terms of human resources.

2 VALENCY OF ADJECTIVES

2.1 Systemic ellipsis of complements in adjectives

Most investigation into valency is concerned with verbs. The valency of non-verbal predicates, nouns and adjectives, is still under-researched. The valency of Czech adjectives has been outlined by Daneš et al. (1987), and described in the light of corpus data by Kopřivová (2006) and recently by Najbrtová (2017). Systematic attention has been paid to this issue in the Functional Generative Description (FGD), which serves here as the theoretical background as well (see esp. Panevová 1998; Kolářová et al. 2021). Moreover, the valency of selected nouns and adjectives is captured by Svozilová et al. (2005) and recently in the valency lexicons NomVallex

[1] The examples come from the Czech National Corpus, SYN v13, acessible at https://www.korpus.cz/. Examples that are not indicated are modified. The numbers stand for cases (1=Nom, 2=Gen, 3=Dat, 4=Acc, 6=Loc, and 7=Ins). The conjunction marks dependent clauses. The sign ↑ indicates that a valency complement cannot be expressed on the surface although it is present in the deep structure (Sect. 2.1).

[2] The inheritance of valency applies to deverbal, deadjectival or denominal nouns, too.

(Kolářová et al. 2024) and PDT-Vallex (Urešová et al. 2024). However, the numbers of nouns and adjectives included in these lexicons are still limited.

In the valency theory of FGD, five actants are distinguished, based on the syntactico-semantic criteria: ACTor, ADDRressee, PATient, EFFect, and ORIGin. The information on valency is captured in the valency frame, which is modeled as a sequence of valency slots. Each slot stands for one valency complement. For each complement, the valency frame provides the information on its type and obligatoriness. Morphemic forms then indicate surface realization of the complement. The number and type of valency complements determine the deep valency whereas morphemic forms indicate the surface valency.

The surface valency of adjectives is specific, as one of adjectival complements is systematically elided from the surface, despite being present in the deep valency of the adjective. The antecedent of this complement is expressed out of the adjectival structure either as the governor of the adjective, see the antecedent of ADDRessee *matka* 'mother' in (2), or as the subject of the copular construction, see the antecedent of ACTor *lidstvo* 'humankind' in (4). As examples (2) and (4) show, the complement that is subject to the systemic ellipsis can vary in type.

2.2 Inheritance of valency in adjectives

"Inheritance is the phenomenon that complex words have properties which are identical to properties of one of their morphological constituents" (Booij 2000, p. 857). Involved in many morphological processes, inheritance concerns (among other properties) valency as well, see, e.g. Bierwisch (2015). Accordingly, we can observe that the valency of deverbal adjectives corresponds, at least to some extent, to that of their base verbs and can be thus considered inherited from verbs.

In the case of the *deep valency*, two situations occur. First, a deverbal adjective fully inherits all the complements from its base verb. As a result, it has the same number and type of complements, see the adjectives *obvinitelný* 'accusable' (2) and *polepšitelný* 'corrigible' (4) above. Second, a deverbal adjective inherits only some of complements from its base verb, see the adjective *znalý* 'knowledgeable' (6) that lacks the complement ORIGin compared to its base verb *znát* 'know' (5).

(5) *znát* 'to know'
ACT_{1}^{obl} $PAT_{4,zda,cont}^{obl}$ $ORIG_{od+2,z+2}^{opt}$
... byl vzdělaným mužem, který znal řečtinu a hebrejštinu od svých předků.
'... he was an educated man, who knew Greek and Hebrew from his ancestors.'

(6) *znalý* 'knowledgeable'
$ACT_{\uparrow}^{obl}$ $PAT_{2,že,cont}^{obl}$
... byl vzdělaným mužem, znalým řečtiny a hebrejštiny. (SYN v13)
'... he was an educated man, knowledgeable in Greek and Hebrew.'

In contrast to the deep valency, the *surface valency* of adjectives differs from that of the verbal one each time. As the surface realization of complements is indicated by morphemic forms (Sect. 2.1), changes in the surface expression of complements can be detected based on changes of their morphemic forms. Two situations in deverbal adjectives can occur concerning morphemic forms of their complements. First, morphemic forms remain the same or undergo so-called systemic changes, i.e. those changes that allow complements of deverbal adjectives to be expressed in the adjectival structure. These involve (i) the change of Nom into Instr or *od*+Gen,[3] and (ii) the surface ellipsis of one of adjectival complements (Sect. 2.1), see (2) and (4) above. Second, some complements of deverbal adjectives exhibit non-systemic changes of their morphemic forms, cf. the form of ACTor of the adjective *čtivý* 'readable' *pro*+Acc (8) with Nom of ACTor of its base verb (7).

(7) *číst* 'to read'
ACT_{1}^{obl} $PAT_{4,o+6,zda,že,cont}^{obl}$
Knihu čtou rádi i čtenáři, kteří nejsou odborníci na právo.
'Even readers who are not experts in law enjoy reading the book.'

(8) *čtivý* 'readable'
ACT_{pro+4}^{obl} $PAT_{\uparrow}^{obl}$
kniha čtivá i pro čtenáře, který není odborníkem na právo (SYN v13)
'the book readable even for readers who are not experts in law'

2.3 Modelling valency frames of deverbal adjectives using inheritance

We suppose the following mechanism to account for the valency of deverbal adjectives: a verb provides its valency frame, and the suffix used in the derivation of a deverbal adjective modifies it, resulting in the valency frame of the deverbal adjective. Changes in the valency of deverbal adjectives are thus attributed to the suffixes used in their derivation. To model the valency frames of deverbal adjectives based on the valency frames of their base verbs thus presupposes to correctly identify the changes brought about by each suffix. This task, however, poses a challenge due to the fact that there is no one-to-one correspondence between individual suffixes and valency changes: the same suffix can give rise to different valency changes and, conversely, one and the same change can be produced by different suffixes (Bierwisch 2015). Modelling valency frames of deverbal adjectives thus requires several steps:

[3] Kolářová et al. (2021) categorize the change of Acc into Gen in adjectival complements as systemic as well. This view is justified by the fact that in deverbal nouns Acc systematically changes into Gen. However, in deverbal adjectives, this change is attested only in the deverbal adjectives with the partial inheritance of the deep valency, see the complement PATient in (6) above. This issue thus deserves further investigation.

(i) A sufficiently large sample of deverbal adjectives with the same suffix has to be compared with their base verbs in order to determine the valency changes the suffix produces.

(ii) Those suffixes that induce the same valency changes are clustered together.

(iii) Formal rules describing the valency changes in deverbal adjectives are formulated for individual clusters.

(iv) Based on these rules, the valency frames of deverbal adjectives are derived from the valency frames of their base verbs.

(v) The accuracy of the derived valency frames is verified in the corpus data and the rules are modified, if necessary.

3 A CASE STUDY: ADJECTIVES *-TELNÝ* 'ABLE'

We illustrate tasks (i), (iii), (iv) and (v), introduced in Sect. 2.3, with the deverbal adjectives with the suffix *-telný*, see (2) and (4) above, focusing on challenges that arise in each step.[4] These adjectives denote potential affectedness by an event expressed by their base verbs. We select this type as these deverbal adjectives are expected to fully inherit the deep valency from their base verbs, and their surface valency is supposed to be subject to systemic changes (Sect. 2.2). Moreover, these deverbal adjectives are part of derivational morphology, whereas, e.g. verbal adjectives (e.g. *obviňující* 'accusing' and *obviněný* 'accused', see esp. Jelínek 2003), which exhibit the full inheritance of valency complements displaying surface systemic changes, can still be viewed from a certain perspective as part of verbal inflection.

To identify the valency changes produced by the suffix *-telný* we compared the valency frames of the adjectives with this suffix contained in NomVallex[5] (47 in total) with the valency frames of their base verbs in VALLEX.[6] Based on this comparison, two rules are formulated. The first rule describes the changes in the valency of the adjectives *-telný* that represent the so-called passive type (e.g. *dělitelný* 'divisible', *přemístitelný* 'movable', *využitelný* 'usable'), where the systemic surface ellipsis affects the complement expressed in base verbs by Acc (Sect. 3.1). The second rule applies to those adjectives that are of the active type (e.g. *polepšitelný* 'corrigible', *přizpůsobitelný* 'adaptable', *rozptýlitelný* 'distractible'), where the nominative complement of base verbs is elided (Sect. 3.2). This split of rules is conditioned by the advanced semantic information on the type of reflexive verbs.

[4] As a preliminary study, we limit ourselves to one suffix, thus leaving aside step (ii).

[5] http://hdl.handle.net/11234/1-3420

[6] http://hdl.handle.net/11234/1-4756

3.1 Rule 1: Passive type

Passive type of adjectives *-telný*	
conditions	¬reflexverb: decaus|autocaus & SE ACT_1 & X_4[ADDR|PAT|EFF]
ACT	* → 7
X	* → ↑
Y	jako+4 → jako+1
obligatoriness	X

Fig. 1. Rule 1 determining the changes in the valency frames of adjectives *-telný* of the passive type

The first row of the rule determines the conditions on which the rule is applied to a valency frame of a verb. The conditions specify that the verb is not a decausative or autocausative reflexive verb[7] with the reflexive *se* in its lemma (¬ rules out a certain value and & indicates 'at the same time'). Further, it requires the nominative ACTor and at the same time ADDRessee, PATient or EFFect in Acc in its frame (represented by the variable X).

The second row captures changes in the valency frame of the verb needed to derive the valency frame of the adjective. First, it determines that all the forms of ACTor (represented by the sign *) are changed into Instr. Second, it specifies that all the forms of the complement in Acc, represented by the variable X, are replaced by ↑, indicating its surface ellipsis. Third, it states that the complement expressed by the form *jako*+Acc, represented by Y (typically EFF or COMPL), changes its form into *jako*+Nom. Lastly, the rule determines that the complement X must be obligatory (even if it is optional in the valency frame of the verb).

Other complements from the valency frame of the verb, including their forms, remain preserved.[8] See examples below.

- X=PAT

napravit 'to correct' → *napravitelný* 'corrigible'
ACT_1^{obl} PAT_4^{obl} → ACT_7^{obl} $PAT_{\uparrow}^{obl}$
Ve většině pracovních kolektivů je případná chyba napravitelná samotným pracovníkem
'In most teams, a potential mistake is corrigible by the worker themselves'

[7] For decausative and autocausative reflexive verbs see Geniušienė (1987).

[8] We leave aside that the complement X can be marginally expressed by Gen as well (cf. *sotva si povšimnout detailů*$_{gen}$ 'to hardly notice details' and *sotva povšimnutelné detaily* 'hardly noticeable details').

- X=PAT, Y=EFF

vnímat ‘to perceive’ → *vnímatelný* ‘perceivable’
ACT_1^{obl} $PAT_{4,že}^{obl}$ EFF_{jako+4}^{obl} → ACT_7^{obl} $PAT_{\uparrow}^{obl}$ EFF_{jako+1}^{obl}
Deseti Oscary oceněná West Side Story, byť dnes vnímatelná jako přece jen rozvleklá
‘West Side Story awarded ten Oscars, though now perceivable as somewhat lengthy’

Remark on Rule 1. ACTor of adjectives *-telný* can be marginally expressed by the form *od*+Gen (e.g. *je od něho ovlivnitelná* ‘she is influenceable by him’), by Dat that can alternate with *pro*+Acc (e.g. *Můj pracovní zápřah ... je asi mnohým lidem*/*pro mnohé lidi těžko vůbec představitelný* ‘My workload ... is probably hard for many people even to imagine’). The latter forms typically occur in the adjectives *-telný* derived from mental verbs. The occurrence of *od*+Gen is more tricky. We can observe that this form is typically accepted by the adjectives *-telný* derived from base verbs whose Acc complement is filled with an animate participant (e.g. *vydíratelný* ‘blackmailable’).

3.2 Rule 2: Active type

Active type of adjectives *-telný*	
conditions	reflexverb: decaus|autocaus & SE ACT_1
ACT obligatoriness	* → ↑ ACT

Fig. 2. Rule 2 determining the changes in the valency frames of adjectives *-telný* of the active type

The conditions determine that the rule is applied to decausative or autocausative reflexive verbs with the reflexive *se* in their lemmas and that these verbs have the nominative ACTor. In the valency frame of the derived adjectives, all the forms of the ACTor are overwritten by ↑, indicating that this complement is elided from the surface. The rule further states that ACTor is obligatory in the valency frame of adjectives (regardless of its possible optionality in the valency frame of the base verb). Other complements remain unchanged. See example below.

napravit se ‘to correct oneself’ → *napravitelný* ‘corrigible’
ACT_1^{obl} → $ACT_{\uparrow}$
nenapravitelný hříšník
‘incorrigible sinner’

3.3 Ambiguity and compound adjectives

It should be pointed out that those adjectives to which Rule 2 relates are ambiguous: they are either of the active type or the passive type (see, e.g. the adjective *napravitelný* ‘corrigible’ in Sect. 3.1 and 3.2). The source of ambiguity is

as follows. First, non-reflexive verbs with the accusative complement undergo reflexivization, resulting in decausative and/or autocausative reflexive verbs. Then both non-reflexive and reflexive verbs are base verbs from which adjectives *-telný* are derived: the non-reflexive verbs motivate the passive type of adjectives *-telný* with the valency frames produced by Rule 1, while reflexive verbs are the basis for the active type of adjectives, the valency frames of which result from Rule 2.

Further, the same valency frames as those derived by Rule 2 underlie the valency of a specific type of adjectives *-telný*, namely compounds of the Pron+Adj type (e.g. *samořiditelný* 'self-driving'). The accusative complement of their base verbs is occupied by the reflexive pronoun (e.g. *auta*$_{\text{nom}}$ *řídí sebe*$_{\text{acc}}$ *sama* 'the cars drive themselves') that becomes part of the adjectival lemma and is thus dropped from the valency frame of the adjective (e.g. *samořiditelná auta* 'self-driving cars'). The only complement remaining in its frame is the ACTor that undergoes the surface ellipsis. As a result, these adjectives can be attributed the same valency frame as the adjectives of the active type, produced by Rule 2, although their base verbs satisfy the conditions introduced by Rule 1.[9]

3.4 Derivation of valency frames and their verification

Based on Rule 1 and 2, introduced in Sect. 3.1 and 3.2, respectively, 2,937 valency frames were derived for adjectives *-telný*. First, verb lemmas representing lexical units of verbs satisfying the conditions set in Rule 1 and 2 were extracted from VALLEX (3,040 lexical units represented by 2,655 verb lemmas, for Rule 1, and 507 lexical units and 718 verb lemmas for Rule 2; lexical units describing idioms were filtered out). For each verb lemma, an adjective *-telný* was searched in DeriNet:[10] 1,234 and 350 adjectival lemmas *-telný* derived from the verb lemmas identified by Rule 1 and 2, respectively, were obtained (only adjectival lemmas attested in corpus data were taken into account). For these adjectives, 2,482 and 455 valency frames based on Rule 1 and Rule 2, respectively, were derived from the valency frames of their respective base verbs. See Tab. 1.

	Number of lemmas	Number of valency frames
Rule 1 all	2,731	6,019
Rule 1 excl. idioms	2,669	5,253
Rule 1 attested in corpus	1,234	2,482
Rule 2 all	710	937
Rule 2 excl. idioms	703	905
Rule 2 attested in corpus	350	455

Tab. 1. Adjectival lemmas *-telný* and valency frames derived for them based on Rule 1 and 2

[9] However, these compound adjectives are rare (in SYN v13 there are 33 lemmas with 5,490 occurrences of the type *samo.*telný*, and 7 lemmas with 15 occurrences of the type *sebe.*telný*).

[10] http://hdl.handle.net/11234/1-3765

The accuracy of the derived valency frames was verified in the corpus data. For 40 adjectives *-telný,* 100 corpus sentences were randomly selected from SYN v13 and annotated with respect to the systemic surface ellipsis and other valency complements. 88% of instances represent the passive type governed by Rule 1, while 12% are of the active type described by Rule 2. The annotation shows that both rules correctly determine the systemic surface ellipsis. Further, only less than 3% of valency complements of selected adjectives were expressed on the surface; their forms were identified with almost 88% accuracy. The lower figure results from the inaccurate determination of the form of ACTor, due to the form *pro*+Acc which alternates with Instr. We thus propose to integrate this form of ACTor as an alternative to Instr into Rule 1.

4 CONCLUSION

We have proposed the procedure of modelling the valency frames of adjectives based on the valency frames of their base verbs. In the case study focused on the adjectives *-telný*, we have shown that this task is feasible. However, to achieve high precision it requires rich linguistic information. Last but not least, the case study has shown that the assertion that valency is unpredictable is not generally valid and that the valency of some derived words can be modeled based on the valency of their base words. This fact can be further used in building valency lexicons.

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