FrameBank: A Database of Russian Lexical Constructions

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Abstract. Russian FrameBank is a bank of annotated samples from the Russian National Corpus which documents the use of lexical constructions (e.g. argument constructions of verbs and nouns). FrameBank belongs to FrameNet-oriented resources, but unlike Berkeley FrameNet it focuses more on the morphosyntactic and semantic features of individual lexemes rather than the generalized frames, following the theoretical approaches of Construction Grammar (C. Fillmore, A. Goldberg, etc.) and of Moscow Semantic School (J.D. Apresjan, E.V. Paducheva, etc.).

Keywords: Russian · Construction Grammar · Frames · Corpus linguistics · Morphosyntax · Semantic roles · Polysemy

1 Background

FrameBank¹ is an open access database which consists of a dictionary of Russian lexical constructions and a corpus of their uses tagged with a FrameNet-like annotation scheme [1-3]. The examples are randomly taken from the Russian National Corpus [4]. At present the dictionary provides data for ca. 4000 target verbs, adjectives, and nouns, and the corpus part includes ca. 50000 annotated examples.

The project under discussion started in 2011. The ideology of FrameBank has obviously been inspired by Berkeley FrameNet [5], but there are some crucial differences in how these two resources are organized. Firstly, FrameBank is more focused on morphosyntactic patterns than FrameNet. This is determined by the grammatical properties of Russian (which are not relevant in English), where different case structures often help to profile the situation differently. Secondly, the target entries in FrameNet are extralinguistic situations – frames, which are further linked to a list of semantically related verbs (e.g., the frame of Motion embraces such lexical units as *to come, to go, to fly, to float, to glide, to blow*, etc.). On the contrary, FrameBank has

The work was partly supported by the Russian Foundation for the Humanities, grant No.13-04-12020, and by the Russian Basic Research Foundation, grant No. 15-07-09306.

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¹ www.framebank.ru.

[©] Springer International Publishing Switzerland 2015 M.Y. Khachay et al. (Eds): AIST 2015, CCIS 542, pp. 1–11, 2015. DOI: 10.1007/978-3-319-26123-2_34

particular lexical items as target entries, providing data on their morphosyntactic patterns and on the frames corresponding to different meanings of a lexeme.

The theoretical basis of FrameBank includes Construction Grammar (C. Fillmore, A. Goldberg, etc.) as well as some approaches developed in the Moscow Semantic School (J.D. Apresjan, E.V. Paducheva et al.) with its attention to the differences between close synonyms and to the interaction between lexical and grammatical features of lexical items. There is another resource developed within the Moscow Semantic School – namely, the Lexicographer database [6]. However, it does not seem to equally embrace all the main semantic classes of Russian verbs and all the possible constructions of the verbs it includes. Neither is it directly linked to a set of corpus examples, which is one of the main features of FrameBank.

The paper is structured as follows. After outlining how the dictionary of constructions is designed, we discuss the annotation scheme and some theoretical issues it raises. Further, we consider two databases included in FrameBank: the graph of semantic roles and the graph of formal and semantic shifts between constructions. The graph of semantic roles presents our own inventory, which correlates with the semantic classification of verbs and forms a hierarchy in order to support flexible search options. The other graph shows both formal changes of verbal constructions (omission of a participant, change of a morphosyntactic pattern, diathetic alternations etc.) and their semantic changes (metaphor, metonymy, and also some shifts which have not been discussed so widely, like specialization or rebranding). FrameBank also provides quantitative data on the frequency of semantic roles and semantic shifts, which could be used in the automatic annotation of texts (e.g. for the tasks of semantic role labelling). Finally, we outline some future steps in developing FrameBank.

2 Dictionary of Construction Patterns

We will discuss the architecture of FrameBank using the example of verbs, which form the core of the database. Information about each lexical construction is stored as a construction template, which includes:

- 1. the syntactic rank of the element (Subject, Object, Predicate, Peripheral, Clause);
- the morphosyntactic features of the element² (including POS, case and preposition marking);
- 3. its status: lexical constant vs. variable;
- 4. the semantic roles of the argument (e.g., Agent, Patient, Instrument);
- 5. the lexical-semantic class of the element (e.g., human, animate, abstract entity, means of transport, etc.);
- 6. the morphosyntactic features of the target lexical unit itself (e.g. impersonal, passive participle, etc.);
- 7. one or several examples.

Figure 1 shows a sample pattern in the dictionary.

² This part was originally based on [7].

C	ID230. Cx name: Pjatno vystupilo na rubaške ['a stain appeared on the short']. Cx Pattern: Snom V na + Sloc.											
Γ	Cx	Pl	Letter	tter Head P		Explication	Syntactic	Lexico-	Status			
L	Item						Rank	semantic	[obligatory /			
L	ID							constraints	optional]			
Γ	2077	1	X	Snom	NPnom	Theme	Subject	natural	Oblig.			
L				[Nominative				object				
L				case]								
Γ	2078	2	2 – vystupit' ['to		-	to appear	Predicate	-	Oblig.			
L				appear; lit. to					_			
L				step								
L	,			forward']								
	2079	3	Y	na + Sloc	na +	Location	Peripheral	space and	Oblig.			
V				[preposition	NPloc			place				
I				<i>na</i> 'on' +								
1				Locative								
				case]								
	Tar		1									
	of target words			Index of Morphosyntactic Items								

Fig. 1. The template of the construction *Pjatno*[Noun.Nom] *vystupilo*[Verb] *na rubaške* [PREP + Noun.Loc] 'a stain appeared on the short'.

Each verb is followed in the database by a list of lexical constructions in which it serves as a target word (each construction is named by a mnemonic sentence label). Lexical constructions are grouped in clusters usually corresponding to a particular lexical meaning; the constructions belonging to one cluster differ in the number of explicit arguments and in their morphosyntactic marking. Figure 2 shows two groups of LexCxs of the verb vystupit' to step forward' which correspond to the frame of motion and the frame of coming into existence, respectively.

Target Lexeme: vystupit' 1. 'to step forward' ID220. <Snom V> Vystupilo srazu pjat' soldat 'Five soldiers stepped forward at once' ID221. <Snom V PR from+S>. Iz stroja vystupil čelovek 'A man stepped forward from the line' ID222. <Snom V PR to+S> On vystupil na seredinu komnaty 'He stepped forward to the center of the room' ... 5. 'to appear (about blood, tears, stains, etc.)' ID 230. <Snom V na.PR+Sloc> Pjatno vystupilo na rubaške 'A stain appeared on the short' ID 231. <Snom V na.PR+Sloc u.PR+Sgen> Sljozy vystupili u nee na glazax lit. 'Tears appeared on the eyes at her' ID 232. <Snom V u.PR+Sgen ot.PR+Sgen> U nee ot smexa vystupili sljozy lit. 'Tears appeared at her from laughing'

Fig. 2. The passport of the lexeme vystupit'

3 Corpus Annotation

The dictionary of constructions is supplemented by examples tagged manually. The examples are randomly selected from the Russian National Corpus, each target lexical unit is illustrated by up to 100 sentences with their pre- and post-context. Each example is annotated by one of the annotators in the online FrameBank Markup environment, and then is checked and corrected by the editor. An example is matched to a suitable construction pattern, which includes establishing correspondences between their elements and assigning morphosyntactic and semantic features of the arguments in a particular example. If an example does not fit any of the existing patterns, an annotator should add a new item into the dictionary of constructions (this is often the case for colloquial constructions, for the on-going changes in the semantics of verbs, and for idiomatic expressions). Note that the participants of a frame are annotated irrespective of their syntactic relation to the predicate (this distinguishes FrameBank from the treebanks like SynTagRus or Prague Dependency Treebank). For example, if we annotate the verb vyslušat' 'listen to somebody' and come across sentence (1), we will mark the NPs 'Andropov' and 'the marshal' as the participants of the frame referred to by the verb vyslušal 'listened' (the fact that they are not syntactically related to the predicate will also be mentioned in the annotation).

(1) <u>Andropov</u> prin'al <u>maršala</u> v svojem rabočem kabin'et'e, vyslušal i ob'eščal razobrat's'a v etoj probl'em'e 'Andropov</u> received <u>the marshal</u> in his office, **listened** to him and promised to examine the problem'

The annotators of FrameBank also mark non-standard types of constructions or non-standard variants of argument realization, such as passive, imperative, participial or converbal constructions, constructions with infinitives, control, genitive of negation. The annotation takes into account not only construction arguments and the properties of the predicate, but also adjuncts and modal particles. More details on the annotation procedure can be found in the full version of the manual for annotators, which is available online³.

4 Semantic Roles

As has already been mentioned, construction patterns in FrameBank contain information on the semantic roles of the participants. The inventory of semantic roles may have quite different volume and structure depending on the particular research task and theoretical framework (see, for example, [8: 587–588, 9, 10, 11: 125–126, 12: 370–377]). The most important principles governing the inventory of semantic roles in FrameBank are as follows:

• the inventory should be hierarchical in order to support flexible search options (it may be reduced to 5–10 basic roles, or enlarged to several dozen labels);

³ http://framebank.wikispaces.com/.

- the roles should correlate with the semantic classification of verbs (what follows from this is that traditionally "broad" roles such as Agent or Patient should get different labels in different semantic classes, cf. Agent in destruction vs. speech vs. motion);
- the scope of a semantic role is defined in accordance with the Prototype Theory: for instance, the prototype of Patient is a participant changing under the physical influence of an Agent; peripheral examples (Patient of a non-physical process, Patient which is not changing, Patient created as a result of a physical action) get specific labels (Theme, Result, etc.) and are considered as specific types of Patient.

The detailed list of semantic roles currently contains 91 items classified into seven domains (those of Agent, Possessives, Patient, Addressee, Experiencer, Instrument, Settings), which are further subdivided into smaller units. Initially, we intended to use a list of semantic roles suggested in [12: 370-377]. However, we had to work out some of its parts in further detail in order to be in line with our theoretical principles. For instance, the inventory suggested by J.D. Apresjan includes the role of Experiencer without any further semantic specification. To achieve our goals, we considered Experiencer not as a single semantic role, but as a domain including Subject of Perception ('see', 'hear'), Subject of Mental State ('think', 'understand'), Subject of Psychological State ('love', 'be afraid'), Subject of Physiological State ('feel pain', 'have a buzzing in one's ears'), Subject of Physiological Response ('tremble with cold', 'feel sick'), and Subject of Psychological Response ('laugh', 'cry (burst into tears)'). Similarly, the role of Agent is defined in our inventory as an active (prototypically animate) participant of a situation, intentionally changing something in the world. This role is typically assigned to verbs of physical impact, eating and drinking, creation, causation of motion, while more specific verbs which are less closer to the prototype of Agent receive their own semantic roles (Speaker, Subject of motion, Subject of social relationship, etc.).

It should also be noted that the principles of FrameBank annotation allow marking double roles (following the ideas of [11: 140]). Thus, examples like *kormit' r'eb'enka* <u>s</u> <u>ložečki</u> **'to feed** a child <u>with a spoon</u>' or *myt's'a <u>pod kranom</u>* **'to wash oneself** <u>under a</u> <u>tap</u>' contain instrumental participants, which at the same time have locative properties (which influences their morphosyntactic marking). Therefore, these participants receive a double role Instrument and Place in our annotation scheme.

FrameBank also provides frequency data about semantic roles in lexical constructions. Table 1 shows the top-15 roles (the calculation is based on the number of construction patterns with this role; the data on the other roles are left out of this paper due to size limits). These data supplemented with the morphosyntactic patterns may be useful for the tasks of semantic role labelling [13, 14], see [15] for a case study based on FrameBank.

5 Non-core Elements

Along with marking the arguments of target lexical units, the annotation of examples in FrameBank covers their adjuncts (non-obligatory valencies), see, for instance, [8: 72–79] on the theoretical foundations of the distinction between arguments and adjuncts.

Semantic role	Number of construction patterns	Example	Number of predicates in the dictionary
Agent	4787	<u><i>Prodav'ec r'ežet syr</i> 'The seller</u> is cutting cheese'	1824
Patient	3086	<i>Prodav'ec r'ežet syr</i> 'The seller is cutting cheese'	1498
Theme	1591	<i>Na polu l'ežal <u>č'elovek</u></i> 'There was <u>a</u> <u>man</u> lying on the floor'	1004
Subject of motion	1520	$\frac{My}{to Moscow'} jed'em v Moskvu 'We are going to Moscow'$	515
Speaker	1304	$\frac{On}{truth'} govorit pravdu 'He is telling the$	749
Patient of motion	1049	<i>Mal'čik v'el <u>sl'epogo</u> za ruku</i> 'The boy led a blind man by the hand'	358
Point of destination	921	My jed'em <u>v Moskvu</u> 'We are going to Moscow'	657
Place	903	<u>Na polu</u> l'ežal č'elovek 'There was a man lying on the floor'	738
Message	776	On skazal, čto rabotajet nad knigoj 'He said <u>that he was working on a</u> book'	454
Effector	643	<u>V'et'er</u> povalil d'er'evo 'The wind threw down a tree'	565
Subject of psychological state	643	<u>On</u> toskujet po druz'jam ' <u>He</u> misses his friends'	526
Mental content	637	My sčitali jego opasnym č'elov'ekom 'We considered him <u>a dangerous</u> person'	438
Content of action	634	<i>Potrudit'es' <u>vstat'</u>, požalujsta!</i> 'Be so kind to stand up, please!'	526
Result	633	Mama svarila <u>sup</u> 'Mother has cooked <u>soup</u> '	445
Reason	616	Komandira b'espokoilo, jesli razv'edčiki dolgo n'e vozvraščalis' 'The commander was worried <u>if</u> the scouts didn't return long'	501

Table 1. Frequency of semantic roles in FrameBank (top-15).

This provides large amounts of empirical evidence for discussing the restrictions imposed on the combinability of adjuncts with different types of predicates (cf. a traditional view touched upon in [8: 75] and stating that arguments are specific for each verb, while adjuncts are compatible with various verbs). Table 2 contains statistical data on co-occurrence of verbs and adjuncts depending on the semantic classes of both.

verb class	time	place	degree	manner	usualness	reason	duration	simultaneity	sequence	purpose	precision	frequency	comparison	speed
motion	426	<u>172</u>	<u>133</u>	219	148	93	107	62	58	64	26	38	74	82
speech	120	131	<u>44</u>	139	68	56	31	18	24	18	22	38	11	9
physical impact	70	89	44	80	36	28	33	20	21	19	4	24	12	7
emotion	69	44	<u>224</u>	21	41	39	21	11	11	6	29	3	8	
mental	79	79	40	36	31	28	32	18	17	12	21	5	6	
social interaction	71	64	58	41	43	35	14	17	9	11	13	10	6	4
start of existence	90	104	5	24	27	29	8	28	17	18	4	13	5	2
possessive	62	69	10	20	12	14	7	14	2	25	4	5	2	3
psychical	33	22	71	8	16	22	14	16	6	5	9	2	3	6
sound	17	42	2	16	9	2	2	5	6	2	7	2	2	
physiology	23	21	18	12	10	6	6	4	5		2	2		2
change of state	17	8	12	15	15	10	8	6	5	4		6	4	4
end of existence	19	6	10	2	10	8	7	8	10		4	5	1	8
SUM	1096	851	671	633	466	370	290	227	191	184	145	153	134	127

Table 2. Co-occurrence of verbs and adjuncts.

As can be seen in Table 2, the ratio of co-occurrence is much higher than average for verbs of emotion and the psychical sphere with adjuncts of degree, for verbs of motion with adjuncts of time, speed and comparison, for verbs of speech with adjuncts of manner and place, for verbs expressing start of existence or possessive relations with adjuncts of place (the overrepresented combinations are marked in bold). On the contrary, the ratio of co-occurrence is lower than average for verbs of motion and adjuncts of place, degree, reason and precision, for verbs of speech and adjuncts of degree and time, for verbs of physical impact and adjuncts of time, etc. (the underrepresented combinations are marked with a gray background; the least represented cases are on a dark-gray background). Interestingly, adjuncts referring to usualness, frequency, simultaneity and sequence do not tend to favor any particular verb class. Nevertheless, the data of FrameBank show that the combinability of adjuncts is not arbitrary: the choice of an adjunct with a particular semantics is to some extent predetermined by the semantic class of a verb.

6 Construction Grapher

Another component of FrameBank is the graph of lexical constructions. It documents the systematic relations between constructions. First, it systematizes semantic shifts in verbal lexemes (metaphor, metonymy and some more complex relations). Second, the graph represents formal changes in argument structure, such as omission of a participant, diathetic alternations (cf. [8]), the inheritance of a pattern from another verb etc. The semantic part of the project is inspired by FrameNet grapher as well as by E. Rakhilina's research database on Russian polysemous adjectives and adverbs (see [16]

and references therein). The formal part is guided by E. Paducheva and G. Kustova's theoretical and empirical analysis of polysemy in Russian verbs [6, 8, 17].

The types of formal and semantic changes are represented below (for the previous stage of its discussion see [3]). The figures in brackets after the name of a shift indicate the number of its occurrences in the database. Sometimes a construction undergoes more than one formal or semantic change, in such cases all changes are counted. For each verb in the database we construct a graph showing the formal and semantic changes undergone by its constructions. These graphs are tied into a larger graph of lexical constructions, since some edges of the latter establish linkages between different verbs, consider "Inheritance of a pattern" below. A case study of how the construction grapher works can be found in [18].

6.1 Formal Changes

- Morphosyntactic alternation (1796): Vy govorit'e pravdu 'You are telling the truth' ↔ Papa govorit, <u>čto bojat's'a n'ečego</u> 'Father says that there is nothing to be afraid of' ↔ <u>"Moemu drugu groz'at n'eprijatnosti"</u>, – govoril on <u>"My friend is facing troubles</u>", – he said'. This formal change is bidirectional (as well as all the changes marked with the left-right arrow), as we assume all the morphosyntactic variants to have equal status in the graph, instead of choosing the primary one, which would often be not quite evident.
- 2. Focus shift between participants (1230): Žuravli l'et'at <u>s vostoka</u> 'The cranes are flying from the east' ↔ Lastočki l'et'at <u>na jug</u> 'The swallows are flying to the south' ↔ <u>Nad gorami</u> letit or'el 'An eagle is flying over the mountains' In particular, this change is typical of motion verbs. We treat all the constructions with a mover + one locative participant as basic and formally interrelated by means of a focus shift, instead of deriving them from constructions like *Pticy l'et'at s vostoka na jug nad gorami* 'The birds are flying from the east to the south over the mountains', as the latter ones are quite rare in our corpus data and do not seem to be natural for human language.
- Diathetic alternation (407): <u>Korma lodki</u> ušla v vodu '<u>The stern of the boat</u> plunged (lit.: went) into water' → <u>Lodka</u> ušla v vodu <u>kormoj</u> 'lit.: <u>The boat</u> went into water with its stern'.
- Omission of a participant belonging to a definite class (335): On rastvor'aet sahar <u>v</u> vod'e 'He is dissolving sugar in water' → On rastvor'aet sahar 'He is dissolving sugar'.
- 5. Omission of a participant which is deictically or situationally defined (875): Avtobus prišel <u>na stanciju</u> 'The bus arrived <u>at the station</u>' → Begite, avtobus prišel! 'Hurry up, the bus <u>has arrived</u>!'
- 6. Omission of an indefinite (or unimportant) participant (1152): Korabl' plyv'et <u>iz</u> <u>gavani</u> 'The ship is sailing from the harbour' \rightarrow Korabl' m'edl'enno plyv'et 'The ship is sailing slowly'.
- 7. Addition of a participant (2269): Lastočki l'et'at 'The swallows are flying' → Lastočki l'et'at <u>za kormom</u> 'The swallows are flying to find some food' This formal shift usually involves adding peripheral participants like Goal, Reason,

Method, etc. Omission is in its turn marked when there is a core participant of a frame missing in a derived construction (e.g., Instrument in the frames of destruction or any kind of locative participant in the frames of motion).

- Hybrid of two constructions (91): Ptica prygala <u>po trav'e</u> 'A bird jumped <u>on the grass</u>', Ptica prygala <u>p'er'ed domom</u> 'A bird jumped <u>in front of the house</u>' → Ptica prygala <u>po trav'e p'er'ed domom</u> 'A bird jumped <u>on the grass in front of the house</u>'.
- 9. Inheritance of a pattern (706): "Sl'edujt'e za mnoj", skazal oficiant "Follow me", – said the waiter ' \rightarrow '"Sl'edujt'e za mnoj", – brosil oficiant "Follow me", – dropped the waiter' The annotation of such examples sheds light on the most productive sources of inherited morphosyntactic patterns. These are the verbs govorit' 'to speak, to say' (66 constructions acquiring its pattern), nakazat' 'to punish' (32 cases), bol'et' 'to be ill' (21 cases), bit' 'to beat' and udarit' 'to hit once' (total 20 cases), dat' 'to give' (14 cases), byt' 'to be' (12 cases). The position of govorit' at the top of the list can be explained by the high productivity of metaphors referring to speech, as well as by the frequent occurrence of metonymic contexts which describe expressing emotions, cf. "Vot eto fokus!" - udivils'a on 'lit.: "What a trick!", he was surprised' In this example the verb udivit's 'a 'to be surprised' not only denotes the emotional state of the experiencer, but also indicates that he is saying something. The latter part of meaning is supported by the use of direct speech inherited from verbs like 'to say'. In the case of bol'et' 'to be ill', the number of inherited patterns is high, as this semantic domain is inherently metaphorical: according to the cross-linguistic data analyzed in [19], most pain sensations are described with verbs borrowed from other domains (burning, cutting and breaking, sound, etc.), rather than with specific pain expressions. This semantic shift tends to be accompanied with morphosyntactic changes which make source verbs more "similar" to verbs of pain in their construction patterns (see [19] for details). The case of the verb nakazat' 'to punish' is a bit different. Many verbs become embedded into a construction with the preposition za + NPacc describing Motivation. This argument is typical of nakazat' and occurs with other verbs when they denote an action evaluated as punishment, cf. ar'estovat' za ubijstvo 'to arrest for murder', iskl'učit' iz komandy za opozdanije 'to expel from the team for being late', S'erg'ej byl ostanovl'en policijej za to, čto projehal na krasnyj signal sv'etofora 'Sergej was stopped by the police for running a red light'.

6.2 Semantic Changes

- Metonymy: an associated participant (517): <u>Voda</u> zam'erzla '<u>The water</u> has frozen' → <u>Prud</u> zam'erz '<u>The pond</u> has frozen up'.
- Metonymy caused by diathetic alternations (432): <u>Pojezd jed'et v gorod</u> '<u>The train</u> is going to the city' → Ja jedu v gorod <u>pojezdom</u> 'I am going to the city <u>by train</u>'.
- 3. Metonymy: an associated domain (726): Vasilij int'er'esujets'a russkoj lit'eraturoj 'Vasilij is interested in Russian literature' → Vasilij int'er'esujets'a, vo skol'ko prihodit pojezd 'Vasilij wonders (lit.: is interested) when the train arrives' Here in the first example the verb int'er'esovat's'a 'to be interested in sth.' describes the

mental state of the experiencer, while in the second example it shifts to expressing the speech of a person aiming at find something out.

- 4. Metaphor (5498): *Mat' budit* <u>syna</u> 'Mother is waking <u>her son</u>' \rightarrow *Tišina budit* <u>vospominanija</u> 'Silence evokes (lit.: wakes) <u>memories</u>'.
- 5. Rebranding (146): a semantic shift where the derived meaning is an implicature from the source meaning [16], e.g. *Smotri:* zv'er' podhodit 'Look: a beast is **approaching**' \rightarrow *Eto pal'to t'eb'e podhodit* 'This coat suits (lit.: **approaches**) you' In this example the idea of something approaching, conveyed in the direct use, implies meeting some standard as a figurative meaning. However, these two domains are not adjacent and therefore are not related metonymically. Neither is there a direct metaphoric relation which could be established between these two meanings.
- 6. Idiomatization (89): On ulybnuls'a *i* prot'anul <u>ruku</u> 'He smiled and stretched his hand' → Vy tak nogi prot'an'et'e 'You'll turn up your toes (lit.: stretch your legs)'.
- 7. Specialization (94): *Po utram on pjet* $\underline{\check{caj}}$ 'He drinks tea in the morning' $\rightarrow On$ *pjet* 'He drinks (abuses alcohol)'.
- 8. Semantic bleaching (46): *javl'at's'a* 'to be (lit.: to come, to appear)'; *obratit'* vnimanije 'to pay (lit.: to turn) attention'.

7 Future Prospects

In the previous sections we have discussed the main parts of FrameBank: the dictionary of construction patterns, the annotation of constructions in corpus examples, the graphs of semantic roles and of shifts between constructions. Since FrameBank is an ongoing project, its development entails many further goals and challenges. The first task is to work out a graph of frames which could tie the constructions from the dictionary to the ontological classification of the lexicon. Although this graph may be to a great extent based on the broad inventory of semantic roles already existing in the database, it will sometimes require a more fine-grained semantic specification of the verbal ontology. The second task is to enlarge the database with constructions of nouns, adjectives, and adverbs which are now on the periphery of our research. It will also be promising to add full-text annotation, as this would allow studying the distribution and interaction of constructions in paragraphs and large texts.

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