Building the Turkish FrameNet

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Abstract

FrameNet (Lowe, 1997; Baker et al., 1998; Fillmore and Atkins, 1998; Johnson et al., 2001) is a computational lexicography project that aims to offer insight into the semantic relationships between predicate and arguments. Having uses in many NLP applications, FrameNet has proven itself as a valuable resource. The main goal of this study is laying the foundation for building a comprehensive and cohesive Turkish FrameNet that is compatible with other resources like PropBank (Kara et al., 2020) or WordNet (Bakay et al., 2019; Ehsani, 2018; Ehsani et al., 2018; Parlar et al., 2019; Bakay et al., 2020) in the Turkish language.

1 Introduction

Introduced in 1997, FrameNet (Lowe, 1997; Baker et al., 1998; Fillmore and Atkins, 1998; Johnson et al., 2001) has been developed by the International Computer Science Institute in Berkeley, California. It is a growing computational lexicography project that offers in-depth semantic information on English words and predicates. Based on the theory of Frame Semantics by Fillmore (Fillmore and others, 1976; Fillmore, 2006), FrameNet offers semantic information on predicate-argument structure in a way that is loosely similar to wordnet (Kilgarriff and Fellbaum, 2000).

In FrameNet, predicates and related lemmas are categorized under frames. The notion of frame here is thoroughly described in Frame Semantics as a schematic representation of an event, state or relationship. These semantic information packets called frames are constituted of individual lemmas (also known as Lexical Units) and frame elements (such as the agent, theme, instrument, duration, manner, direction etc.). Frame elements can be described as semantic roles that are related to the frame. Lexical Units, or lemmas, are linked to a frame through a single sense. For instance, the lemma "roast" can mean to criticise harshly or to cook by exposing to dry heat [1]. With its latter meaning, "roast" belongs to the Apply_Heat frame.

With this study, we aimed to recreate a comprehensive FrameNet in Turkish language following Fellbaum's notions related to Frame Semantics theory. For this purpose, we referred to English FrameNet's frames and Turkish WordNet's properties. In order to ensure compatibility with Turkish WordNet (KeNet) and Turkish PropBank (TRopBank), we used the same lemma IDs.

In this paper, we present our attempt at building a Turkish FrameNet. In Section 2 titled Towards a Turkish FrameNet, we explain our motivation,

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[1] Definitions are taken from Merriam-Webster Dictionary at https://www.merriam-webster.com/dictionary

methodology and processes along with the challenges we faced during this study. In Section 3 we present our results and discuss these results in Section 4. Finally, we conclude with our suggestions regarding further study in Section 5.

2 Towards a Turkish FrameNet

2.1 Motivation

With this study, we aim to take the first step towards creating a comprehensive and coherent Turkish FrameNet that is able to illustrate the semantic richness and the typological properties of Turkish language. We intend to provide a certain level of correspondence between Turkish FrameNet and English FrameNet to allow using Turkish FrameNet in machine translation tasks and various other multilingual NLP processes. Another aspiration of ours is to build a FrameNet for Turkish that can be interconnected with other NLP resources in Turkish like PropBank (Kara et al., 2020) and WordNet (KeNet) (Bakay et al., 2019; Ehsani, 2018; Ehsani et al., 2018; Parlar et al., 2019; Bakay et al., 2020) in order to create state-of-the-art parsers, semantic role labelling tools and similar NLP applications with high accuracy and speed.

In many languages, the teams behind creating these resources are different. That is why finding a way to use more than one of them at the same time or in the same NLP application is a very challenging task which requires additional steps and many resources including time. In Turkish the same team created PropBank, WordNet and FrameNet. Moreover, same lemmas and synsets across these resources have the same IDs. As a result, it is possible to find the WordNet entry, PropBank entry or FrameNet frame of the same predicate only by using its ID number. In other words, combining these resources does not require an additional step or extra effort. We believe that such a coordination and compatibility would make it significantly easier to create NLP solutions that employ two or all three of these resources for increased accuracy.

2.2 Methodology

In this section, two different aspects of the methodology will be discussed: First the strategy, then the annotator team and their roles.

When examined closely, FrameNet projects of different languages adopt one of the two main strategies (Candito et al., 2014):

- A frame-by-frame approach that first creates frames and then fills them with Lexical Units. This approach is very prominent in FrameNet studies and employed by the vast majority.

- A lemma-by-lemma approach that brings together semantically similar Lexical Units to create their corresponding frame. This approach is fully adopted by the German FrameNet project SALSA (Burchardt et al., 2006; Burchardt et al., 2009) (and partially employed by Japanese FrameNet (Ohara et al., 2004; Ohara et al., 2003; Ohara et al., 2009; Ohara, 2008)).

Both strategies propose a set of advantages and challenges. As stated by Candito et al. (2014), the frame-by-frame approach ensures the coherency within the frames while lemma-by-lemma approach allows the annotators to unveil the full semantic range of a given lemma by discovering rarer senses and larger units encompassing many lemmas (Burchardt et al., 2009). Although a lemma-by-lemma approach leads to a more comprehensive analysis of the Lexical Units, it also creates a "biased" lexicon for "only senses pertaining to covered frames will appear in the lexicon, and these senses are not necessarily the most frequent senses of that lemma (Candito et al., 2014)." Moreover, a lemma-by-lemma approach makes it considerably more difficult to develop frames and build parent-child, inheritance and lateral relationships between these frames.

As neither of these strategies is objectively and ultimately "better," we turned to our data in order to choose the most viable strategy for building a Turkish FrameNet. Since a comprehensive Turkish PropBank (Kara et al., 2020) and Turkish WordNet (Bakay et al., 2019; Ehsani, 2018; Ehsani et al., 2018; Parlar et al., 2019; Bakay et al., 2020) was already available for Turkish, a quick research can show that Turkish has more than 18,000 documented predicates. Adopting a frame-by-frame approach to incorporate them all in a Turkish FrameNet would be unrealistic, if not impossible. On the other hand, choosing a lemma-by-lemma approach would take a painstakingly long time. As a low-resource language, Turkish's need for a FrameNet is very evident and rather urgent -especially when it is considered that an attempt for creating a Turkish FrameNet is made more than two decades after the English

FrameNet. That is why the best solution was opting for a hybrid strategy put forward by Candito et al. (2014) for building French FrameNet.

Our motivation for choosing a hybrid strategy was mostly related to efficiency: We aimed to release a version of Turkish FrameNet that captures at least a considerable majority of the most frequent predicates, thus offering a valuable and practical resource from day one. Because Turkish is a low-resource language, it was important to ensure that FrameNet had enough coverage that it could be incorporated into NLP solutions as soon as it is released to the public.

Following the footsteps of French FrameNet, we took a closer look at Turkish WordNet and designated 8 domains that would possibly contain the most frequent predicates in Turkish: Activity, Cause, Change, Motion, Cognition, Perception, Judgement and Commerce.

For the first phase, the focus was on the thorough annotation of these domains. Frames from English FrameNet were adopted when possible and new frames were created when needed. In the next phase[2], our team of annotators will attack the Turkish predicate compilation offered by TRopBank and KeNet for a lemma-by-lemma annotation process. This way, both penetration and coverage of the Turkish FrameNet will be increased.

Following the annotation strategy, we decided upon the roles of annotators. In the development process of the English FrameNet, 3 different teams worked (Baker et al., 1998): Vanguards who come up with frames, Annotators who match Lexical Units and Frame Elements with frames, and Rearguards who review lexical records and create lexical entries for lemmas and frames. In our study, we opted out of this workflow. Instead, we divided annotators to four teams of two. Each annotator was given a domain. Their duty was creating frames within that domain by translating and adopting related frames from English FrameNet. Then they had to extract lexical units from TRopBank and KeNet, annotate their frame elements, write sample sentences and annotate these sentences. During these processes, members of each team kept in touch and reviewed one another's annotations. Moreover, all teams and annotators met weekly for discussions and decision-making processes. After the annotation process was finished, a member of the team carefully went through all frames, sentences, LUs and FEs to ensure coherency and agreement. After disputable cases were discussed among the team, she fixed all issues.

The sample sentences in Turkish FrameNet were extracted from TDK Dictionary [3] when possible. Otherwise, annotators came up with novel sentences. Refer to Figure 1 for an annotated frame.

As stated in the previous section, one of our main goals was to create a Turkish FrameNet that is compatible with other NLP resources like TRopBank and KeNet in Turkish. That is why we used KeNet's synsets and lemma IDs in Turkish FrameNet. In other words, we did not annotate single lemmas as Lexical Units, instead we annotated synsets that share the same semantic and syntactic properties. For instance, wordnet synset with TUR10-0354260 ID number contains two predicates: "ısıtmak" and "sıcaklaştırmak." Both predicates:

- Literally mean "to heat,"

- Share a definition,

- Assign the same case to their internal argument,

- Give the Agent role to their external argument,

- Can be used interchangeably without any loss to the sense.

Thus, we added this synset in Apply_Heat frame (See Table 1)

Since both syntactic and semantic criteria was considered while creating synsets in KeNet, TRopBank uses these synsets as lemmas. As we aimed to make FrameNet as compatible as possible with both TRopBank and KeNet, we decided to use these existing synsets as well. Considering the fact that items in a synset share the same meaning, have the same number of arguments and assign the same theta roles to these arguments, we believe that taking them as Frame Units does not conflict with the theory behind FrameNet and does not negatively affect the accuracy. Moreover, it can even be argued that annotating synsets in their related frames provides additional information regarding the synonymy.

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[2]Only the first phase is within the scope of this paper.

[3]https://sozluk.gov.tr

Frame	Definition	Lexical Unit Id	Lexical Unit Synset	Lexical Unit Definition	Frame Elements
Attempt	An Agent attempts to achieve a Goal. The Outcome may also be mentioned explicitly.	TUR10-0192570	denemek	Bir işe, başarmak amacıyla başlamak, girişimde bulunmak, teşebbüs etmek	Agent, Goal, Circumstances, Effort
		TUR10-1160410	teşebbüse geçmek	bir işi yapmak için davranmak, girişmek	Agent, Goal, Circumstances, Effort, Manners
		TUR10-1160420	teşebbüs etmek	girişmek, el atmak	Agent, Goal, Circumstances, Effort, Manners
		TUR10-0479350	koyulmak	Girişmek, başlamak, teşebbüs etmek	Agent, Goal, Manners
		TUR10-1032280	girişimde bulunmak	davranmak, teşebbüs etmek	Agent, Goal, Circumstances, Effort, Manners
		TUR10-1183220	yerini yapmak	bir şey elde etmek amacıyla girişimde bulunmak	Agent, Goal, Circumstances, Effort, Manners
		TUR10-0298660	girişmek	Kalkışmak	Agent, Goal, Manners

Figure 1: Attempt frame

Table 1: Apply_Heat Frame

Frame	Lexical Unit ID	Synset	Definition
Apply_Heat	TUR10-0354260	ısıtmak, sıcaklaştırmak	Sıcak duruma getirmek
Apply_Heat	TUR10-1154650	tava getirmek	Gereği kadar ısıtmak
Apply_Heat	TUR10-0810920	ütmek	Taze buğday veya mısırı ateşe tutup pişirmek
Apply_Heat	TUR10-0810910	ütmek	Bir şeyi, tüylerini yakmak için alevden geçirmek

2.3 Maintaining Inter-Annotator Agreement

In order to ensure inter-annotator agreement, members of each group kept in touch and consulted one another regarding debatable Lexical Units and frames. Moreover, the annotation interface allowed annotators to see, comment on and mark each other's annotations. Each week, all annotators had a meeting where they discussed ambiguities, marked annotations and challenging Lexical Units.

After the annotation process was completed, a team member took on the role of controller and went through every frame, Lexical Unit and its annotation to look for inconsistencies. The inconsistencies or potential issues detected by her were thoroughly discussed by the entire team. Afterwards, she fixed these issues and changed annotations when necessary.

Amongst all domains, Change posed most problems. A significant amount of predicates annotated in this domain were also present in frames that belonged to other domains. For instance, many predicates that implied a deliberate change of location by an Agent were annotated in both Change and Motion domain. Considering the nature and theoretical background of FrameNet, it is not surprising to find out that some predicates belong in two different frames (e.g. "koşmak" *(run)*,

see 2), but a significant overlap is often an indicator of a serious problem. That is why the team of annotators discussed the common predicates in Change domain and other domains like Motion and Cognition. Since Change denotes a massive domain, team members almost scrutinised it to ensure that only both semantically and syntactically related predicates were annotated in the frames of this domain.

After careful inspection, some predicates were removed from this domain and some new subframes like Cognitive Change were created.

2.4 Challenges

For we took English FrameNet's frames as the guideline in this study, significant issues we faced were related to the typological differences between these two languages. As thoroughly discussed by Kara et al. (2020), Turkish has significantly more unaccusative verbs and lexicalized, figurative multi-word predicates. Thus, categorization of these Lexical Units posed a serious challenge. Unaccusative verbs do not take an agent or patient per se. Often they are used with expletives. That is why they are syntactically different from other verbs but from a semantic point of view, they are very similar with many accusative, transitive and ditransitive verbs. A per-

fect example of this phenomena can be seen in Activity_Paused_State frame. "dinmek" *(stop)* is only used for precipitation and takes no internal arguments (objects) while "dondurmak" *(freeze)* can be used for individuals and takes internal arguments (objects). Although their valency and argument structure differs significantly, both verbs conform to the definition of Activity_Paused_State frame[4]. After thorough discussions, our team of annotators decided upon including unaccusative verbs or lexicalized, figurative multi-word predicates. The reasoning behind this decision is the fact that FrameNet is a resource whose primary focus is on semantic properties of the Lexical Units. That is why even nominal forms like "moratorium" or "to freeze" are included in related frames in English FrameNet. Such unaccusative verbs are marked in their definition. If they are used only with an expletive or a certain lexical element, this is mentioned in the definition, e.g. "dinmek" *(stop)*. It is used only for precipitation, thus its external arguments can only be "kar" *(snow)*, "yağmur" *(rain)*, "dolu" *(hail)* or "tipi" *(blizzard)*. This is explicitly mentioned in the definition of this lexical entry, which can be found in Turkish FrameNet, WordNet and PropBank.

Another challenge was posed by the fact that some English Lexical Units have no correspondent in Turkish. As a result, it was not possible to recreate some English frames in Turkish, such as Activity_Ready_State. As a solution, we simply abandoned such frames. In contrast, some frames like Frugality were much richer than their English counterparts. For such instances, we divided those frames into subframes in accordance with the semantic properties of their Lexical Units. For the Frugality case, we introduced 3 subframes: Frugality_Time, Frugality_Waste and Frugality_Money (see Table 2 for frame statistics). The reason behind was the mere pattern displayed by Turkish predicates. When we brought together all predicates that belong to the Frugality frame, we noticed a pattern: From a semantic and syntactic point of view, it was possible to divide these Frugality predicates into 3 subcategories. While creating such sub-categories or creating new frames, we considered argument number and structure along with case and thematic role assignment of the predicates.

In addition to dividing richer and broader

frames, we also needed to create new frames like Games_Jargon[5] in order to properly illustrate the intricate semantics of Turkish. The decision to create a new frame for Turkish was taken when there were multiple predicates that share at least one intrinsic semantic or syntactic feature that sets them apart from the closest English frame. A good example is Deprivation frame, created for Turkish FrameNet. Similar frames from English FrameNet are Deny_or_Grant_Permission, Preventing_or_Letting and Change_Access. In Deny_or_Grant_Permission frame, the focus is on allowing or disallowing a protagonist to engage in an action. Preventing_or_Letting frame refers to the situations where an agent can hinder something from happening. And finally, Change_Access frame refers to the access to a physical location. In Deprivation frame, an Agent or Authority deprives an entity or a group of entities of things they require for staying alive or completing a task. Although similar to the existing frames in English, Deprivation frame refers to a novel notion. Since there are multiple predicates in Turkish that correspond to this notion (7, to be exact), our team of annotators decided that creating such a frame was appropriate.

The main motivation behind our responses to the challenges we faced was being able to offer a coherent FrameNet for Turkish instead of a mere translation of English frames and Lexical Units. Although this adaptation based approach lowers the correspondence with English to some degree, the vast majority of the frames are parallel. That is why Turkish FrameNet is a resource fit for both Turkish NLP projects and bilingual NLP projects like machine translation.

3 Results

In this study, a total number of 139 Frames in 8 domains were created[6]. 16 of these frames were created specifically for Turkish while the remaining 123 are translated from English FrameNet. These frames include a total number of 2769 synsets (See Table 2). As we used Turkish WordNet and PropBank's repositories, the Lexical Units were made

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[4]An Agent pauses in the course of an Activity.

[5]This frame contains Lexical Units related to tabletop games and board games.

[6]https://github.com/StarlangSoftware/TurkishFrameNet
https://github.com/StarlangSoftware/TurkishFrameNet-Py
https://github.com/StarlangSoftware/TurkishFrameNet-Cy
https://github.com/StarlangSoftware/TurkishFrameNet-C#
https://github.com/StarlangSoftware/TurkishFrameNet-CPP

Table 2: Statistics

Total Frames	139
Unique Frames	16
Synsets (LUs)	2561
Individual Predicates	4080
Frame Elements	203

Table 3: A comparison with initial versions of other FrameNets

Language	Frames	LUs
French	98	662
Chinese	322	3947
Swedish	51	2300

of wordnet synsets. Thus some LUs contain more than one predicate. The total number of predicates annotated in this study is 4080. In other words, 4080 predicates were annotated into their respective frames. Sample sentences of all were marked up for the specific roles in them.

Compared to initial versions of French FrameNet, Chinese FrameNet and Swedish FrameNet, the Turkish FrameNet developed by this study offers a promising coverage (see Table 3). It must be noted that French, Chinese and Swedish FrameNets have been being developed further, thus their current coverage is better than their initial versions.

4   Discussion

The aim of this study was creating a useful resource for Natural Language Processing studies in Turkish. Offering 139 frames, 2561 synsets and 4080 Lexical Units, this study can be considered as a very satisfactory first step towards this goal. In addition, Turkish FrameNet is created in correspondence with English FrameNet. Rather than being a mere translation, Turkish FrameNet employs new frames when necessary but maintains its close ties with English FrameNet. That is why it can be used in both Turkish NLP studies and English-Turkish translation applications. Moreover, this close correspondence to English FrameNet makes it possible to introduce cross-correspondence between Turkish and various other FrameNets that use same or similar frames as English FrameNet.

In many other languages, NLP resources like PropBank, WordNet and FrameNet use different identification and processing systems for their lemmas. That is why it is rather challenging to integrate them and create enhanced, state of the art NLP solutions. On the other hand, Turkish Prop-Bank TRopBank, Turkish WordNet KeNet and Turkish FrameNet use the same set of lemmas. As a result, individual synsets have the same IDs across all platforms. That is why it is possible and relatively easier to integrate these three resources and create cutting edge NLP tools or train highly accurate semantic annotators. Such streamlined databanks and corpora offer a great value to NLP studies in low resource languages like Turkish.

Due to being able to easily correlate, TRopBank and Turkish FrameNet can be used together to empower NLP solutions. Because of its characteristic features, PropBank offers syntactic information regarding the predicates while fails to capture the semantic layer. On the other hand, FrameNet does not offer much information about the valency of a predicate. That is why the combination of these two offer a coherent and thorough analysis for NLP applications. Since the same team is behind creating KeNet, TRopBank and Turkish FrameNet, these three resources share same synsets and lemmas. Thus, they can be used together in the same NLP solution without spending much effort on making them compatible.

5   Further Studies

This study is the very first attempt to a Turkish FrameNet. That is why the primary aim was laying the foundation. In order to create initial frames and include at least some portion of the most commonly used predicates in Turkish, we opted for a top-down approach. In other words, we created 139 frames in 8 domains and added related lexical units into these frames. For the next step, a bottom-up approach may be more appropriate in order to extend the coverage of FrameNet. For this purpose, Turkish WordNet KeNet (Bakay et al., 2019; Ehsani, 2018; Ehsani et al., 2018; Parlar et al., 2019; Bakay et al., 2020) can provide a very useful resource. Annotators can start from the terminal branches and work their way up, creating new frames and building inheritance and/or lateral relationships between frames. In this step, KeNet's own hierarchy can be a guide for creating new frames.

Since this study consists of only 139 frames, the lateral and hierarchical (inheritance) relations between frames are significantly limited. For in-
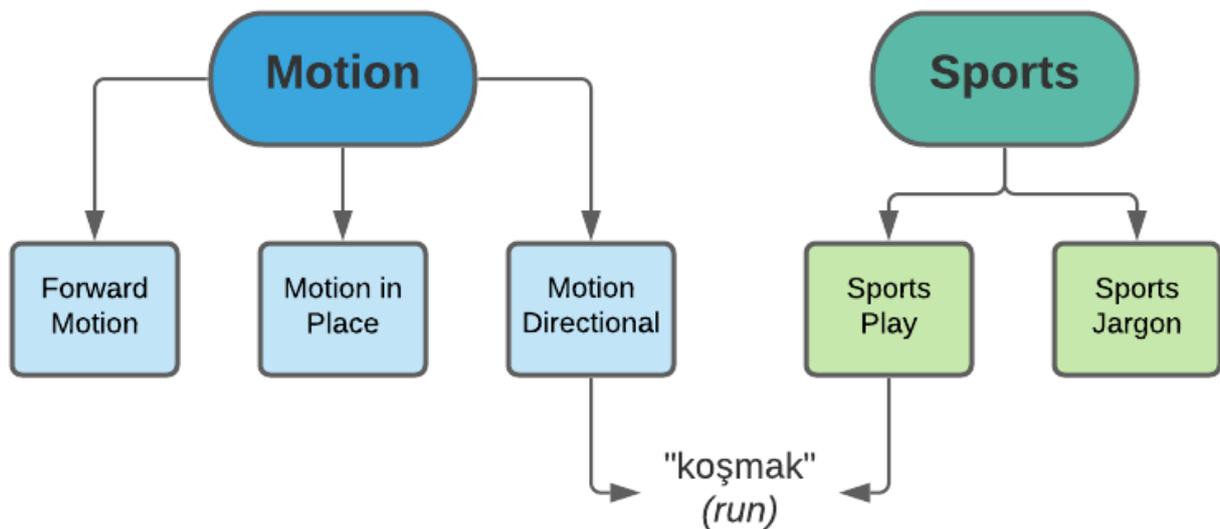
Figure 2: Frame relations

stance, frames within the Motion domain have a strong hierarchical relationship (See Figure 2). For instance, "kaçmak" *(run away)* LU is a member of Forward_Motion frame and its parent frame, Motion.

Yet some Lexical Units in Motion domain also correspond to Sports_Play frame (See Figure 2). The lateral relationship between these two overlapping frames is not strictly defined. Since the number of frames are relatively low at the moment, such refinements are not crucial but as the Turkish FrameNet grows, the necessity of defining both hierarchical and lateral relationships will be indispensable. Again, the relationships determined in KeNet can and should play a pivotal role for such definitions for the sake of coherence.

In this study, English FrameNet (Lowe, 1997; Baker et al., 1998; Fillmore and Atkins, 1998; Johnson et al., 2001) was taken as the baseline. That is why the vast majority of the frames correspond to English ones despite some necessary deviations due to the typological characteristics of Turkish. In the follow-up works, the correspondence between lexical units should be built, so that a cross-language resource that can be used in various NLP applications like machine translation is created.

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