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TRANSLATION-BASED CONSTRUCTION OF AN UZBEK WORDNET FROM PRINCETON WORDNET

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Abstract. This study presents a translation-based methodology for constructing an Uzbek WordNet by leveraging the lexical and semantic structure of Princeton WordNet. As a low-resource language, Uzbek lacks comprehensive semantic networks required for advanced natural language processing applications, including word sense disambiguation, semantic search, and knowledge representation. The proposed approach operates at the synset level and involves translating lemmas, glosses, and semantic relations while preserving the original hierarchical structure. A hybrid pipeline combining automatic neural machine translation and manual refinement is employed to ensure semantic consistency. Special emphasis is placed on gloss-based disambiguation to address polysemy and improve translation accuracy. The study focuses on validating the feasibility of the approach rather than presenting large-scale evaluation results. Therefore, quantitative performance metrics are intentionally deferred to future research, where expanded datasets and expert-driven validation will be incorporated.

Key words: Uzbek WordNet, lexical semantics, synset, natural language processing, machine translation, semantic networks.

Annotatsiya. Ushbu maqolada Princeton WordNet leksik-semantik tuzilmasiga asoslangan holda o‘zbek tili uchun WordNet yaratishning tarjimaga asoslangan metodologiyasi taklif etiladi. Past resursli tillardan biri hisoblangan o‘zbek tilida tabiiy tilni qayta ishlash (NLP) masalalarini samarali bajarish uchun zarur bo‘lgan to‘liq semantik tarmoqlar yetarli darajada rivojlanmagan. Taklif etilgan yondashuv sinset darajasida ishlashga asoslanib, so‘zlar, ularning izohlari va semantik bog‘lanishlarini tarjima qilish bilan birga asl ierarxik tuzilmani saqlashni ko‘zda tutadi. Mazkur metodologiyada avtomatik mashina tarjimasi va ekspert tekshiruvi birlashtirilgan gibrid yondashuv qo‘llanilgan. Ayniqsa, polisemiya muammosini hal qilishda gloss (izoh) asosida ma’no aniqlashtirish muhim rol o‘ynaydi. Tadqiqotda asosiy e’tibor yondashuvning amaliy qo‘llanish imkoniyatini tekshirishga qaratilgan bo‘lib, keng ko‘lamli baholash natijalari keyingi ishlar uchun qoldirilgan.

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Kalit so‘zlar: O‘zbek WordNet, leksik semantika, sinset, tabiiy tilni qayta ishlash, mashina tarjimasi, semantik tarmoqlar.

Аннотация. В данной статье предлагается методология построения узбекского WordNet на основе перевода, используя лексико-семантическую структуру Princeton WordNet. Узбекский язык, являясь языком с ограниченными ресурсами, не обладает полноценными семантическими сетями, необходимыми для решения задач обработки естественного языка, таких как разрешение многозначности, семантический поиск и представление знаний. Предложенный подход основан на переводе на уровне синсетов с сохранением их иерархической структуры и семантических связей. Методология включает гибридный подход, сочетающий автоматический машинный перевод и экспертную проверку. Особое внимание уделяется устранению неоднозначности значений с использованием анализа определений (gloss-based disambiguation). В рамках данной работы основное внимание уделено проверке применимости предложенного метода, тогда как количественная оценка оставлена для последующих исследований.

Ключевые слова: Узбекский WordNet, лексическая семантика, синсет, обработка естественного языка, машинный перевод, семантические сети.

INTRODUCTION.

The rapid advancement of natural language processing (NLP) has significantly increased the demand for structured lexical-semantic resources across a wide range of languages. Among such resources, WordNet has emerged as one of the most influential frameworks for representing lexical knowledge in a machine-readable form. Originally developed as Princeton WordNet[3], WordNet organizes words into sets of cognitive **synonyms** (*synsets*) interconnected through semantic relations such as **hypernymy**, **hyponymy**, and **antonymy**. This structure enables a deeper representation of meaning compared to traditional dictionaries and has become a fundamental component in numerous NLP applications, including word sense disambiguation, information retrieval, semantic search, and question answering systems.

Despite the widespread adoption of WordNet in many languages, some languages such as Uzbek still lack comprehensive and standardized lexical-semantic databases. Existing linguistic resources for Uzbek are primarily limited to traditional dictionaries, morphological analyzers, and corpus-based tools, which do not fully capture semantic relationships between words. This limitation poses a

[3] A lexical database for English: https://wordnet.princeton.edu

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significant challenge for developing advanced NLP systems, particularly those requiring semantic understanding and contextual reasoning.

In recent years, multilingual initiatives have attempted to extend WordNet to other languages, often relying on projection or translation-based methods. These approaches leverage the rich structure of Princeton WordNet to bootstrap new lexical resources in target languages. However, direct translation of lexical entries alone is insufficient, as it does not adequately address issues such as polysemy, cultural specificity, and structural consistency. Therefore, constructing a reliable WordNet for Uzbek requires not only translation but also careful preservation of semantic relations and context-aware interpretation of meanings.

This study addresses the above challenges by proposing a translation-based methodology for constructing an Uzbek WordNet from Princeton WordNet. The central idea is to transfer synset-level information, including lemmas, glosses, and semantic relations, into Uzbek while maintaining the integrity of the original structure. Unlike naive word-to-word translation, the proposed approach operates at the synset level, allowing for more accurate handling of multiple word senses and semantic distinctions.

RELATED WORKS.

Turkish WordNet. Research on WordNet construction for the Turkish language represents one of the most advanced efforts among Turkic languages. A prominent example is the KeNet project, which is considered a large-scale lexical-semantic resource. The system contains 76,757 synsets and models both intra-lingual and inter-lingual semantic relations [1]. The construction of KeNet followed a multi-stage pipeline. Initially, synsets were automatically extracted from machine-readable Turkish dictionaries. These synsets were then manually validated and refined by linguists to ensure semantic correctness. As a result:

✓ *49,774 synonym pairs were annotated,*

✓ *10,612 synsets were enriched with newly written definitions.*

Uzbek WordNet. Compared to Turkish, research on Uzbek WordNet is still in an early stage. One of the key projects is UZWORDNET, developed using the expansion approach based on Princeton WordNet [2]. The dataset includes:

✓ *28,140 synsets,*

✓ *64,389 senses,*

✓ *20,683 lexical entries.*

The system was constructed using the Connectivity Restoration Algorithm (CRA), which maps English synsets to Uzbek equivalents through automated translation and structural alignment. Evaluation results show, initial accuracy 71.79%, after validation 75.98%. Another line of research focuses on constructing

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Uzbek WordNet using Turkish WordNet as a base. This approach leverages linguistic similarity between Turkic languages and relies on expert translation and validation [3]. Additionally, studies based on English WordNet emphasize the expansion methodology, where synsets are translated and later refined using corpus analysis and expert validation [4, 5]. Recent research also compares the Expand and Merge approaches:

✓ Expand: *fast but prone to semantic inaccuracies,*
✓ Merge: *accurate but resource-intensive,*
✓ Hybrid approach: *recommended as the optimal solution.*

The review of existing studies indicates that Turkish WordNet resources have reached a relatively mature stage with large-scale and well-structured semantic networks, whereas Uzbek WordNet development remains limited in both coverage and accuracy. Most existing approaches rely primarily on direct translation (expand method) or partially hybrid strategies, which often fail to ensure precise synset-level alignment and struggle with issues such as polysemy and lexical gaps. In contrast to these works, the proposed study introduces a more robust approach by combining synset-level translation with gloss-based disambiguation while preserving semantic relations, thereby providing a more consistent and scalable framework for constructing an Uzbek WordNet.

METHODOLOGY.

Overview of the proposed approach. This study adopts a translation-based (expand) methodology to construct an Uzbek WordNet by leveraging the latest version of Princeton WordNet. The approach is designed to preserve the original semantic structure while adapting lexical content to Uzbek. Unlike simple word-to-word translation, the proposed method operates at the synset level, ensuring that each concept is transferred together with its semantic relations and contextual meaning. The overall workflow consists of a hybrid pipeline combining automatic translation and expert validation.

Princeton WordNet version and data source. The primary resource used in this study is the latest version of Princeton WordNet, which provides a comprehensive lexical-semantic structure including synsets, glosses, and semantic relations. WordNet is distributed in several formats, including *original database format (.dict), XML representation, and Open Multilingual WordNet (OMW) format.* Among these, the OMW-compatible structured format was selected for this research due to its ease of processing, standardized schema, and compatibility with multilingual extensions.

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WordNet structure and representation. WordNet is organized around synsets, which represent distinct concepts rather than isolated words. Each synset contains:

- a set of synonymous words (lemmas)
- a gloss (definition and example)
- semantic relations to other synsets

The main semantic relations used in this study include: hypernym (generalization), hyponym (specialization), antonym (opposition) and meronym (part-whole relation).

Table 1

Core WordNet relations and uzbek examples

Relation type	Uzbek example	Description
Hypernym	*meva → olma*	general-to-specific relation
Hyponym	*olma → meva*	specific-to-general relation
Synonym	*go'zal, chiroyli*	similarity in meaning
Antonym	*katta ↔ kichik*	opposite meaning
Meronym	*daraxt → shox*	part-whole relation

The proposed pipeline consists of the six steps (shows in Fig. 1). To evaluate the feasibility of the proposed approach, a controlled subset of approximately 500–1000 synsets was selected from Princeton WordNet. The selection was guided by the need to ensure both representativeness and diversity, covering high-frequency lexical units, multiple parts of speech, and different semantic domains. This experimental setup allowed the methodology to be tested under realistic conditions while keeping the process manageable for detailed validation. The translation process itself was designed as a hybrid pipeline, where initial Uzbek equivalents were generated using neural machine translation tools and subsequently refined through expert-driven validation. This combination was necessary because automatic systems alone often fail to capture subtle semantic distinctions, particularly in morphologically rich and agglutinative languages such as Uzbek. A central challenge encountered during the process was polysemy, where a single English lemma corresponds to multiple meanings depending on context. To address this issue, gloss-based disambiguation was applied, in which translated definitions were carefully analyzed to determine the most appropriate Uzbek equivalent for each synset. By aligning translations with their corresponding glosses and semantic context, the methodology ensured that each lexical item was assigned to the correct conceptual representation, thereby improving overall semantic consistency.

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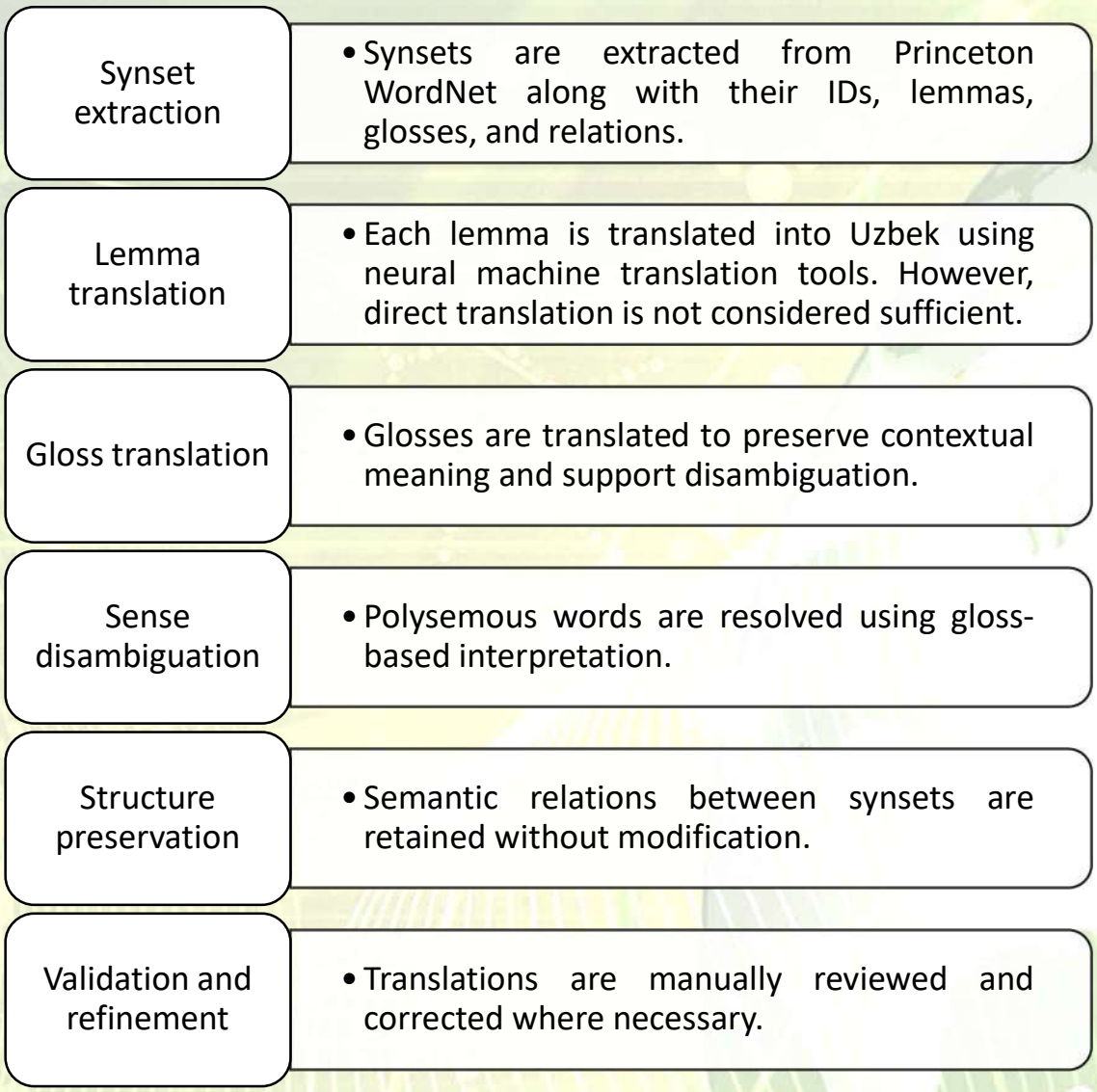


Figure 1. Proposed translation pipeline

The resulting Uzbek WordNet entries were stored in a structured and machine-readable JSON format, enabling efficient integration with NLP systems and facilitating future expansion. Each entry preserves the original synset identifier, part-of-speech information, translated lemmas, gloss, and semantic relations, thereby maintaining compatibility with the original Princeton WordNet structure. This design ensures that the resulting resource is not merely a translated lexicon but a fully functional semantic network. The methodological choices made in this study were guided by the need to balance linguistic accuracy with computational scalability. In particular, the decision to operate at the synset level rather than at the individual word level allowed for more precise handling of semantic distinctions, while the preservation of relational structure ensured the integrity of the network. Furthermore, the integration of automatic translation with manual validation provided a practical compromise between efficiency and quality, making the approach suitable for scaling to larger datasets in future work.

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RESULTS AND EVALUATION.

The application of the proposed translation-based methodology resulted in the successful construction of a preliminary Uzbek WordNet prototype derived from Princeton WordNet. The process demonstrated that synset-level translation combined with gloss-based interpretation allows for the preservation of semantic structure while adapting lexical content to the Uzbek language. The generated entries include translated lemmas, glosses, and semantic relations, confirming that the structural integrity of the original WordNet framework can be maintained within the target language.

At this stage, the primary objective of the experiment was not to produce a fully validated large-scale resource, but rather to test the feasibility and consistency of the proposed pipeline. The results indicate that the methodology is capable of generating semantically structured data that can serve as a foundation for further expansion. In particular, the integration of gloss translation proved essential in guiding the correct interpretation of meanings during the translation process.

It is important to note that a comprehensive quantitative evaluation is not included in this study. Although a subset of synsets was processed during the experimental phase, the results are considered preliminary and not sufficient for drawing statistically reliable conclusions. A full-scale evaluation requires a significantly larger dataset and, more importantly, systematic validation by professional linguists and translators.

DISCUSSION AND CONCLUSION.

The findings of this study highlight both the potential and the inherent challenges of constructing an Uzbek WordNet through a translation-based methodology. The experimental process demonstrates that leveraging the semantic structure of Princeton WordNet provides a practical and scalable foundation for developing lexical-semantic resources in low-resource languages. In particular, the synset-level translation approach proved to be more effective than traditional word-level mapping, as it enables a more accurate representation of meaning and preserves the conceptual relationships embedded in the original resource.

At the same time, the study reveals several linguistic and methodological challenges that must be addressed in future work. One of the most significant issues is polysemy, where a single lexical unit corresponds to multiple meanings across different contexts. In such cases, direct translation often leads to semantic ambiguity or incorrect mappings. The use of gloss-based disambiguation partially mitigates this problem; however, it does not fully eliminate the need for expert validation. This is especially important for Uzbek, an agglutinative language with rich morphological variation and context-dependent semantics.

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