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Telif Hakkı

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			Vahide Nida Kılıç Ali İnan	
	2037	A Practical Investigation of Spear Phishing Spam Emails: Comparative Analysis and Evaluation	Kendrick Kurt Günter Bollens	772 - 777
	2091	Multipurpose Malware Detection System	Mert Gursimsir Cem Ayar Ibrahim Sogukpinar	778 - 782
CRYP	1867	A New Method to Detect Malicious DNS over HTTPS via Feature Reduction	Ali K. Bozkurt Halil E. Aköz Ataberk Taşpınar Şerif Bahtiyar	783 - 788
	1939	Generative Adversarial Networks for Synthetic Jamming Attacks on UAVs	Burcu Sönmez Sarıkaya Şerif Bahtiyar	789 - 794
	1958	Detecting Corruptive Noise Rounds for Statistical Disclosure Attacks	Alperen Aksoy Doğan Kesdoğan	795 - 800
	1996	Future Directions of Cybersecurity in Industrial Internet of Things Through Edge Computing	Tamara Zhukabayeva Lazzat Zholshiyeva Nurdaulet Karabayev	801 - 806
	2061	Resource-Efficient Ensemble Learning for Edge IIoT Network Security against OSINT-based Attacks	Mert İlhan Ecevit Zakire Çukur Muhammed Ali İzgün Noor Ul Ain Hasan Dağ	807 - 812
	2074	Transfer Learning for Phishing Detection: Screenshot-Based Website Classification	Furkan Çolhak Mert İlhan Ecevit Hasan Dağ	813 - 818
	2145	Blok Şifrelerin Karıştırma ve Yayılım Tabakaları için Yeni Bir Analiz Aracı A New Analysis Tool for Confusion and Diffusion Layers of Block Ciphers	Mehmet Ali Demir Meltem Kurt Pehlivanoğlu Pınar Savaştürk Emir Öztürk Muharrem Tolga Sakallı Sedat Akleylek	819 - 824
CVIS	1851	Impact of Image Augmentation on Deep Learning-Based Classification of Granite Tiles	Gaye Ediboglu Bartos Sibel Ünaldı Nesibe Yalçın	825 - 828
	1877	Advanced Facial Expression Classification with CNN-Transformer Integration for Human-Computer Interaction	Ali Azmoudeh Cigdem Altin Gumussoy Hazım Kemal Ekenel	829 - 834
	1936	Word Image Representation at Local and Global Levels Based on Vision Transformers	Baha Edine Harrath Mohamed Mhiri Mohamed Cheriet	835 - 840
	1949	Detecting Duplicate Products in E-Commerce Images Using Siamese Networks	Enis Teper Furkan Eseoğlu Mustafa Keskin	841- 846
	1963	Comparative Analysis of Visual Attribute Tagging Models for Upper-Body Clothing Products	Engin Kaya Mert Yanık	846 - 850
	1986	Development of A Model of Kazakh Sign Language Recognition Based on Deep Learning Method	Aigerim Yerimbetova Bakzhan Sakenov Ulmeken Berzhanova Nurzhan Mukazhanov Elmira Daiyrbayeva Mohamed Othman	851 - 856
	1989	Recognising Kazakh Sign Language with Mediapipe	Aigerim Yerimbetova Diana Kaidina Bakzhan Sakenov Elmira Daiyrbayeva Mussa Turdalyuly Ulmeken Berzhanova	857 - 862
	1990	Ultrason Görüntülerinden Meme Kanseri Teşhisi için Lezyon Tespitli Hibrit Derin Öğrenme Modelleri	Osman Doğuş Gülgün	863 - 868

		Hybrid Deep Learning Models with Lesion Detection for Breast Cancer Diagnosis from Ultrasound Images	Hamza Erol	
	1992	Olumsuz Hava Koşullarında Gemi Tespiti ve Sınıflandırılması Ship Detection and Classification in Adverse Weather Conditions	Yahya İzala Yaşar Becerikli	869 - 874
	2010	Removing Background from Noisy Handwritten Signatures on Banking Documents using GANs	Ege Dinçer Sacide Kalaycı Emre Yurdakul Bilge Köroğlu	875 - 879
	2013	A Faster R-CNN Model for Multi-class Classification and Detection of Land, Air, and Sea Vehicles	Enes Güvelioğlu Çiğdem İnan Acı	880 - 885
	2098	Çelik Hurdasının Sınıflandırılmasında ResNet ve Görüntü Dönüştürücü Tabanlı Modellerin Başarımı	Sefa Temur Levent Karacan	886 - 891
	2117	Advanced Computer Vision Techniques for Reliable Gender Determination in Budgerigars (Melopsittacus undulatus)	Atalay Denknalbant Efe Ilhan Cemalcılar Majid Ahangari Abdussamat Saidburkhan Alireza Zirak Ghazani Erkut Arıcan	892 - 897
	2151	Teslimat Süresi Tahminlerinde Makine Öğrenmesi Modellerinin Yorumlanabilirliği Interpretability of Machine Learning Models in Delivery Time Predictions	Serhat Agit Satıcı Habil Kalkan	898 - 903
	2169	Deep Learning based Order Form Recognition	Enes Alperen Buğaz Orhan Akbulut Aysun Taşyapı Çelebi Uğur Yıldız	904 - 908
	2170	Learning Based Photo Management on Smartphones	Beyza Nur Şenay Orhan Akbulut Aysun Taşyapı Çelebi Uğur Yıldız	909 - 912
	2177	Retinal Disease Classification Using Optical Coherence Tomography Angiography Images	Omer Faruk Aydın Muhammet Serdar Nazlı F. Boray Tek Yasemin Turkan	913 - 918
	2178	Segmentation Based Classification of Retinal Diseases in OCT Images	Öykü Eren F. Boray Tek Yasemin Turkan	919 - 924
	2183	Unsupervised Translation from Shortwave Infrared Images to RGB Images: A Comparative Evaluation	Duygu Tasbas Hacer Yalim Keles	925 - 930
DSCI	**1882**	Automatic Segmentation of Time Series Data with PELT Algorithm for Predictive Maintenance in the Flat Steel Industry	Saygın Kaçar Tuğçe Ballı E. Fatih Yetkin	931 - 936
	1921	Otomobil Kredilerinde Temerrüt Tahmini ve Araç Geri Kazanım Olasılığı Analizi - Bir Segmentasyon Çalışması Default Prediction and Vehicle Recovery Probability Analysis in Auto Loans - A Segmentation Study	Sahin Nicat Anıl Ferdi Kaya	937 - 942
	1955	E-Ticaret Sadakat Programı Müşteri Eğilim Tahmini Customer Propensity Prediction in E-Commerce Loyalty Program	Yunus Emre Gündoğmuş Sinan Keçeci Ege Erdem Emre Rençberoğlu	943 - 946
	1967	Yapay Zeka ve Makroekonomik Göstergeler ile Tüzel Kredilerin Değerlendirilmesi Evaluation of Corporate Loans with Artificial Intelligence and Macroeconomic Indicators	Burak Yüksel Hakkı Berkay Çiçek	947 - 951
	1974	Enhanced Bot Detection on TwiBot-20 Dataset	Mehmet Ali Osman Atik Şevket Umut Çakır Alper Özcan	952 - 956
	1975	Drug-Drug and Drug-Protein Link Prediction on DTINet dataset	Mehmet Ali Osman Atik Yusuf Çelik Alper Özcan	957 - 960
	2029	Perakende Verilerinde Anomali Tespiti ve Döviz Kuru Älilişkisi Üzerine ChatGPT Destekli Yorumlama	Şadi Evren Şeker	961 - 966

		ChatGPT Supported Interpretation on Anomaly Detection in Retail Data and Exchange Rate Relationship	Hatice Nizam-Özoğur	
	2033	Text to SQL Transformation Using LLM: a Comparative Research of T5, Seq2Seq, and SQLNet Models	Zhazira Shaikhiyeva Madina Mansurova Gulshat Amirkhanova	967 - 972
	2076	Sağlık Sigortası Sahiplerinin Davranışsal Analizi ve Kümelenmesi Clustering and Behavioral Analysis of Health Insurance Owners	Omer Sezer Koyuncu Seçil Arslan	973 - 978
	2087	On symbolic Prediction of Time Series for Predictive Maintenance Based on SAX-LSTM	Aykut Güler Tuğçe Ballı E. Fatih Yetkin	979 - 983
	2135	Profiling Driver Behaviors Using AI-Based Methods and Deep Learning Techniques for Improving Road Safety: A Comparative Study of Algorithms	Volkan Oban Mustafa Kaya Güzide Safi İrem Nur Çimen Tubanur Çatak Bulut Karadağ Gökhan Gümüş Aslıhan Çandır Fatih Alagöz	984 - 989
IR	1896	ReRag: A New Architecture for Reducing the Hallucination by Retrieval-Augmented Generation	Robin Koç Mustafa Kağan Gürkan Fatoş T. Yarman Vural	990 -994
	1941	Enhancing Object Detection in Aerial Images Using Transformer-Based Super-Resolution	Aslan Ahmet Haykır İlkay Öksüz	995 - 1000
NET	1985	Proof of Concept Implementation for RSVP TSN Control Plane	Necip Gozuacik	1001 - 1004
	2100	Integrating Blockchain and SDN for Centrality-Aware Virtual Multicast Tree Embedding	Furkan Ayaz Evrim Guler Murat Karakus Davut Hanbay	1005 - 1010
	1969	QoS Aware Routing Approaches in Software Defined Smart Grids	Sedef Demirci	1011 - 1016
	2008	Deep Reinforcement Learning Routing in Mobile Networks	Arif Burak Dikmen Hasari Çelebi	1017 - 1022
RBOT	1942	Endüstriyel Robotik Sistemlerin Güvenlik Doğrulaması Safety Verification of Industrial Robotic Systems	Fatih Furkan Arslan Metin Özkan	1023 - 1028
	2077	EKF Based Localization: Integrating IMU and LiDAR Data in the Hilti SLAM Challenge	Behice Bakır Havvanur Bozömeroğlu Ebu Yusuf Güven	1029 - 1034
SING	1965	Communication (Educational) Kit (HaKi)	Murat Sever Utku Bilgin	1035 - 1038
	2089	Manyetik Parçacık Görüntülemede Sistem Matrisi için Farklı Dalgacık Dönüşümlerinin Seyreklik Seviyesi Karşılaştırması Sparsity Level Comparison of Different Wavelet Transforms for the System Matrix in Magnetic Particle Imaging	Vildan Atalay Aydın	1039 - 1043
	2097	Sparse Channel Estimation For M-QAM-Based Underwater Acoustic Communication Systems	Mhd Tahssin Altabbaa Berkay Tekat Emin Tarik Iseri	1044 - 1048
OTH	1858	The 80/20 Principle in Morphemics-Morphology in the Educational Corpus of the Uzbek Language	Shahlo Khamroeva Bakhtiyor Mengliyev Muyassar Kholova	1049 - 1052
	1904	Gamification as a Tool for Personalized Learning in Inclusive Education	Dilaram Baumuratova Tamara Zhukabayeva Mira Rakhimzhanova	1053 - 1058
	1918	A Metaheuristic Algorithm for the Fixed Charge Transportation Problem	Nermin Kartli	1059 - 1062
	2027	Eğitimde Sürükleyici Teknolojilerin Kullanılması Fırsatlar ve Beklentiler	Atamuratov Rasuljon Kadırjanovich Majıdova Gulhayo Abdırazzoq qızı Bayjonov Furqat Baxramovıch Ongarov Mansurbek Bayrambekovıch	1063 - 1068

			Saydullayev Zafar Erkınovıch	
	2103	Bilgisayar Mühendisliği Öğrencilerinin Perspektifinden Bilişim Hukukunun Güncel Sorunları ve Çözüm Önerileri Current Challenges and Solution Proposals in IT Law from the Perspective of Computer Engineering Students	Sevda Bora Çınar	1069 - 1075
	2200	A Comparison of shcU-Net Based GAN and U-net Based GAN in Adult Dental Segmentation	Gürdal Altundağ Hakan Öcal	1075 - 1080
	1932	Leveraging Quantum Computing and Optimization to Estimate Financial Crashes in Small and Medium-Sized Enterprises	Ege Dincer Berkay Coskuner Ege Bilaloglu Bilge Koroglu	1081 - 1086
SW	**1859**	Investigating The Adoption of International Software Quality Standards in Turkey: A Comprehensive Analysis	Sevgi Koyuncu Tunç	1087 - 1093
	1886	Development of the Functional Structure of the Science and Education Information System	Dauletov Adilbek Yusupbayevich Matyakubova Noila Shakirjanovna	1094 - 1098
	1892	React ve Preact Javascript Çerçevelerinde Karşılaştırmalı Analiz Comparative Analysis on React and Preact Javascript Frameworks	Muhammed Furkan Uygur Nesibe Yalçın	1099 - 1104
	1917	CAGE: A Tool for Code Assessment and Grading	Ümit Kanoğlu Oğuz Kerem Yıldız Hasan Sözer Olcay Taner Yıldız	1115 - 1110
	1957	Extracting Driving Styles from Automotive Sensor Data to Develop Personas	M. Cagri Kaya Tayssir Bouraffa Krzysztof Wnuk	1111 - 1114
	1962	Lojistik Sipariş Dağıtım Entegrasyonu Sürecinde Sipariş Geri Çağırma Süreci Tasarımı ve Yazılım Geliştirmesi Design and Software Development of The Order Recall Progress in The Logistics Order Distribution Integration Process	İklim Barman Ersin Şengül	1115 - 1120
	2009	The Dimension of Green Coding in Software Quality Control Processes	Volkan Abur	1121 - 1126
	2055	Are We Asking the Right Questions to ChatGPT for Learning Software Design Patterns?	Çağdaş Evren Gerede	1127 - 1132
	2060	Optimizing LLVM IR: Transforming Multiplication to Addition for Enhanced Execution Efficiency	Huseyin Karacalı Efecan Cebel Nevzat Donum	1133 - 1138
	2080	Estimation of Software Integration Test Duration via UML Statecharts	Fehim Göler Tolga Ovatman	1139 - 1144
	2093	DIA4M: A Tool to Streamline DevOps Processes of Distributed Cloud-Native Systems	Eren Tarak H. Hakan Kilinc	1145 - 1150
	2111	Software Industry Perception of Academic Collaboration	Deniz Akdur	1151 - 1156
	2139	Görüntü İşlemeyle Doğrulamalı Robotik Test Otomasyon Kullanımı: POS Cihazları Üzerine Uygulama	Miraç Emektar Harun Kadıoğlu Ahmet Efendioğlu Fatih Mehmet Harmancı	1157 - 1161
	2141	VoIP Sistemlerinde Zihin Haritası Tabanlı Test Stratejiler : SIP Pbx Ürünü Üzerine Bir İnceleme Mind Map-Based Testing Strategies in VoIP Systems: A Case Study on SIP Pbx Products	Miraç Emektar Furkan Günaydın Fatih Mehmet Harmancı	1162 - 1167
	2173	A Robust Microservices Framework for Indoor Tracking System Development	Gafur Hayytbayev Kerem Küçük Mahmut Çavur	1168 - 1172
DM	**1927**	Unsupervised Pattern Extraction of Time Series Data for Energy Disaggregation	Şirin Azazi Deveci Melih Günay	1173 - 1178
	1944	Topic Modeling Enhanced Tripartite Graph for Recommendation using Metapaths	Yaren Yılmaz Irem İşlek Şule Gündüz Öğüdücü	1179 - 1184
	1948	Community Detection on Software Library Dependency Graphs using Graph Neural Networks	Şevket Umut Çakır	1185 - 1190

			Mehmet Ali Osman Atik Ümit Deniz Uluşar	
	2190	Enhancing Mesh and Point Cloud Similarity Detection through Geometric Features and ICP	Talha Rehman Abid Mehtap Öklü Cem Yıldız Ali Erman Erten Kamer Kaya	1191 - 1196
	2214	Comparative Analysis and Practical Implementation of Machine Learning Algorithms for Phishing Website Detection	Samad Najjar-Ghabel Shamim Yousefi Payam Habibi	1197 - 1202
	2215	A Technical Analysis and Practical Implementation of Machine Learning Algorithms for Predicting Survival in Breast Cancer Patients	Shamim Yousefi Samad Najjar-Ghabel Hamidreza Shafaei	1203 - 1208
BIG	**1881**	Comparison Between Time Series and Relational Databases	Alpar Türkoğlu Onurcan Ersen Ibrahim Onuralp Yiğit Dincer Unal Hatice Golcuk	1209 - 1212
	1930	A Performance Evaluation Study on a Data Analytics Platform for Emergency Calls	Engin Yakar H. Hakan Kilinc	1213 - 1218
	2079	Adaptive Composite Market Volatility Index (CMVI) for Enhanced Stock Price Forecasting	Rabia Çevik Uğur Barış Özyürek Ali Kanal Vael Kokach Büşra Kocaçınar Oznur Şengel Fatma Patlar Akbulut	1219 - 1223
	2142	Hybrid Deep Learning Framework for Stock Price Prediction Incorporating Technical and Macroeconomic Indicators	Ali Can Turan Vael Kokach Büşra Kocaçınar Oznur Şengel Fatma Patlar Akbulut	1224 - 1228
	2125	Emotion-Aware Multimodal Biometric Identification by using Biosignals	Yekta Said Can Beyzanur Bektan Fatih Alagöz	1229 - 1235
	1854	Özbekçe-Türkçe Otomatik Çeviri Yazılımı için Deyimlerin Veritabanını Teşkil Etmede Karşılaşılan Güçlükler Automatic Translation Software Difficulties in Organizing the Database of Idioms for Uzbek and Turkish	Manzura Abjalova Umida Raşidova Eşref Adalı	1236 - 1240
	2028	Reversible Steganographic System for the Transmission of Personal Medical Data	Elmira Daiyrbayeva Ekaterina Merzlyakova Aigerim Yerimbetova Aigul Mukhitova	1241 - 1246

Araneum Uzbecicum: A Gigaword Web-Crawled Uzbek Corpus

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***Abstract*— We want to introduce a Project of creation of a web-crawled Uzbek corpus. The main steps related to data capture, pre-processing, tokenization, deduplication, PoS tagging and lemmatization are discussed, and some query examples are shown. This article analyzes the problems in the process of creating and lemmatization the corpus of Araneum Uzbecicum. We also show word embeddings created from the Uzbek data. The Word embeddings function serves as a useful tool for researching the semantic relations in the Uzbek language, word context and valence. Also, the paradigm created by the Word embeddings function helps to perfect dictionaries.**

Keywords—Uzbek language, web-crawled corpus, PoS tagging and lemmatization, word embeddings

I. Introduction

After Tatar and Kazakh, Uzbek is the third Turkic language in our corpus. Spoken by approx. 33 million of L1 or L2 speakers in Uzbekistan and several of its neighboring countries, and also being “sufficiently represented” in the Internet, the language is a suitable target for creation of a web-crawled corpus.

In our paper, we would like to introduce a Project aimed at creation of a Gigaword Uzbek corpus that would contain texts in both scripts currently used in Uzbekistan, i.e., modified Latin and modified Cyrillic, respectively. The corpus data is PoS tagged and lemmatized by *Apertium*, processed by the *NoSketch Engine* corpus manager and made available at our web-corpora portal[1].

II. Related Work

In recent years, building web corpora has become a well-established part of linguistics. The Web, teeming as it is with language data, of all manner of varieties and languages, in vast quantities and freely available, is a fabulous linguists' playground. This special issue of Computational Linguistics explores ways in which this dream is being explored.

The use of web corpora in linguistic research has become widespread, so the problem of using web corpora in linguistic research has been studied in depth.

The problems of creating a web corpus using the BootCaT tool for low-resource languages were studied and clear results were obtained.

Several corpora of Turkish languages were developed on the Sketch Engine platform.

“uzb_community_2017” is an Uzbek community corpus based on material from 2017. It contains 663,119 sentences and 9,256,001 tokens [2].

The initial efforts to develop the Uzbek language corpus commenced in Uzbekistan in 2018. While there have been some theoretical articles on the construction of the Uzbek language corpus, the practical developments on the corpus have become more prevalent by 2018. A bibliometric analysis based on Scopus was conducted on corpus linguistics for the period spanning 2017 to 2021 [41]. There is some work about creating a morphological and syntactic tagged corpus for the Uzbek language. Several studies have been conducted on the processing of corpus texts in the Uzbek language [44], [45].

Additionally, several other corpora have been created for the Uzbek language. In particular, the “Educational corpus of the Uzbek language”[3] within the project of the Tashkent State University of Uzbek Language and Literature, the “Uzbek language corpus”[4]; based on the project of the National University of Uzbekistan, the “National corpus of the Uzbek language”. “Alisher Navoi authorship corpus”[5] and the “Diachronic corpus of Uzbek-English newspapers”[6] were developed by independent researchers, are available for free use. Software for the national corpus of the Uzbek language was developed.

Furthermore, it is worth noting the contributions of researchers who have undertaken studies on specific types of corpora. These include articles on the development of the Uzbek author's corpus, the Uzbek-English parallel corpus, Uzbek-Russian parallel corpus and the diachronic corpus of the Uzbek language. There is research in the field of author lexicography and the relationship between author corpora (Anonymous). An algorithm for creating a parallel corpus of the Uzbek and Russian languages was. The theoretical foundations of the Uzbek-English parallel corpus have been developed [42], [43]. A scientific study of the open Uzbek speech corpus and preliminary experiments on speech recognition were conducted.

III. Data for the New Corpus

During the last decade, the methodology and tools for compilation web-crawled corpora has been effectively standardized. In our Project, we were using a collection of tools usually referred to as “Brno Pipeline” available under a

[1] http://aranea.juls.savba.sk/guest/index.html
[2] https://www.sketchengine.eu/uzwac-uzbek-corpus/
[3] https://uzschoolcorpara.uz/
[4] https://uzbekcorpus.uz/
[5] https://alishernavoiykorpusi.uz/
[6] https://mediatextcorpus.com/

FLOSS license[7] . Its main component is SpiderLing[8], a web crawler optimized for downloading textual data. In its latest Version 2.2, it represents a mature, effective and stable tool that is able to get (within our technical infrastructure) as much as two Gigaword of plain text within 24 hours of crawling. The tool also includes a character encoding identification utility; a language detection module that is using samples of texts for the languages to be recognized provided by the user to build the respective language models using character trigram frequencies; and a boilerplate identification and removal tool **..** All the processes work smoothly on the fly, outputting a reasonably clean plain text with only light XML markup encoding some metadata at the document and paragraph level.

To initialize the process, SpiderLing needs a list of seed URLs that are used in the first round of crawling. In our case, the seed list of approx. 2,000 URLs has been obtained by means of the WebBootCat functionality accessible at the Sketch Engine Portal.

The actual crawling was performed during two separate sessions, in December 2020, and March 2024, respectively. The seed URLs for the second one was obtained from the data already downloaded during the first session – the last 100,000 URLs were used, expecting that some of the addresses might meanwhile have changed the contents of the respective web pages, or could be removed during deduplication.

IV. Pre-Tokenization Processing

Though the language identification procedure of SpiderLing works reliably for most languages, it is often not able to discriminate between very close languages using the same script. We therefore perform a secondary language filtering based on character frequencies, making use of the fact that some characters are unique for a particular language. This was also the case of Uzbek that is using the ҳ, қ, ў, and ғ in the Cyrillic script, and o‘, g‘ and ‘ characters or character combinations in the Latin script. The respective thresholds for filtration were established experimentally.

Other filters detect potential mojibake encoding problems appearing as “artifacts” such as *subâ€TMektlarini* or *oÃƒ¢€TMtgan* in the texts – documents with too many suspicious character sequences are identified by means of a series of regular expressions and removed.

V. Tokenization

For various reasons, we perform tokenization as a separate processing step, even in situations when the tagger would prefer to do it as a part of the tagging process. Here again, one of the “Brno” tools is used – Unitok **.**, the universal tokenizer is a Python program using a custom-modified parameter file containing regular expressions for language-specific period-final abbreviations, ordinal numbers, etc. The initial list of Uzbek abbreviations (both in Latin and Cyrillic) presently contains just approx. two dozen items – we hope, however, to be able to expand it after analyzing the processed corpus.

VI. Data Normalization

Now it is necessary to mention one of the peculiarities of the Uzbek language – the simultaneous use of two different scripts, with the speakers being proficient in both of them. This situation is similar to that of the Serbian language, but unlike in Serbia (and Bosnia and Herzegovina), where the digraphia is a result of centuries long development and any of the scripts are widely accepted in almost all situations, official and unofficial, , the de facto digraphia in Uzbekistan is a result of partially unsuccessful transition from Cyrillic to Latin script in early 1990s. According to our observation, the amount of texts in Internet in either of the scripts is about equal, with many websites, including those belonging to government organizations, private companies, or even the Uzbek Wikipedia, provide two versions of their web pages.

We have decided, on one hand, to retain the information on the respective script in our corpus, as we consider it to be an interesting sociolinguistic parameter, and on the other hand to provide transliterated version of all texts, so that users could easily query the corpus. Moreover, this is also necessary as the PoS tagger used expects its input in Latin script.

The other issue is the presence of the “modified letter turned comma” (U+02BB) and “modified letter apostrophe” (U+02BC) characters in the Latin script. Since these characters are absent from most keyboard layouts, they are often replaced by similar ones, such as “left single quotation mark” (U+0218), “apostrophe” (U+0027), or “right single quotation mark” (U+0219), or oven other similarly looking characters, such as an acute or grave accent. As the PoS tagger expects the text to contain canonical forms of these characters only, all these irregularities have to be normalized before further processing.

VII. Deduplication

Web-crawled texts are known to contain a large proportion of duplicate contents at different levels. We have adopted a two-step approach: (partial) duplicates at the document level are removed and not passed to further processing, while paragraph and sentence level deduplication is provided, if required, at the very end of the processing only.

For the document-level deduplication we use a tool called Onion working on the principle of comparing word n-grams from the document processed with those encountered in all previous documents. A document is considered (partially) duplicate if it contains certain proportion of n-grams already seen. Both values, i.e., the length of n-grams to compare and the similarity level is set by the user – we work with 5-grams and 90% threshold as discussed in [45].

VIII. PoS Tagging and Lemmatization

Uzbek unfortunately does not belong to languages with a language model available for the “traditional” multilingual taggers, such as TreeTagger], or at least a lemmatizer like CSTlemma, though we hope the situation might improve in the future.

The baseline morpho-syntactic annotation has been performed by Apertium, that is in fact machine translation tool, yet its morphological module can be used separately for morpho-syntactic annotation. Its main deficiency, for most languages where a language model is available, is a rather small size of the respective morphological lexicon and a limited disambiguation procedure. It is also not able to guess lemmas and/or PoS tags for the out-of-dictionary (OOV) lexical items.

[7] https://corpus.tools/

[8] https://corpus.tools/wiki/SpiderLing

Another problem of using Apertium as a tagger is its “attitude” to data already tokenized. Being a machine translation tool, its lexicon can also contain multi-word expressions than are to be translated as whole units. If such a multi-word unit is encountered in the text, the system decides that a new token to be added, i.e., spoiling the original tokenization that is expected by the overall processing, e.g., to be able to merge the Cyrillic and Latin data. As the Apertiun morphological lexicon is available in a readable form, we have decided to delete all multi-word expressions from it during this initial phase of our Project.

The respective processing steps of tokenization, normalization, PoS tagging and lemmatization are shown in Fig. 1 to 4.

```
<s>
Янги
стратегияни
август
ойига
қадар
Тошкент
шаҳри
миқёсида
тасдиқланиши
режалаштирилмоқда
<g/>
.
</s>
```

Fig. 1. Tokenized sentence in original Cyrillic Script

```
<>
Yangi
strategiyani
avgust
oyiga
qadar
Toshkent
shahri
miqyosida
tasdiqlanishi
rejalashtirilmoqda
<>
.
<>
```

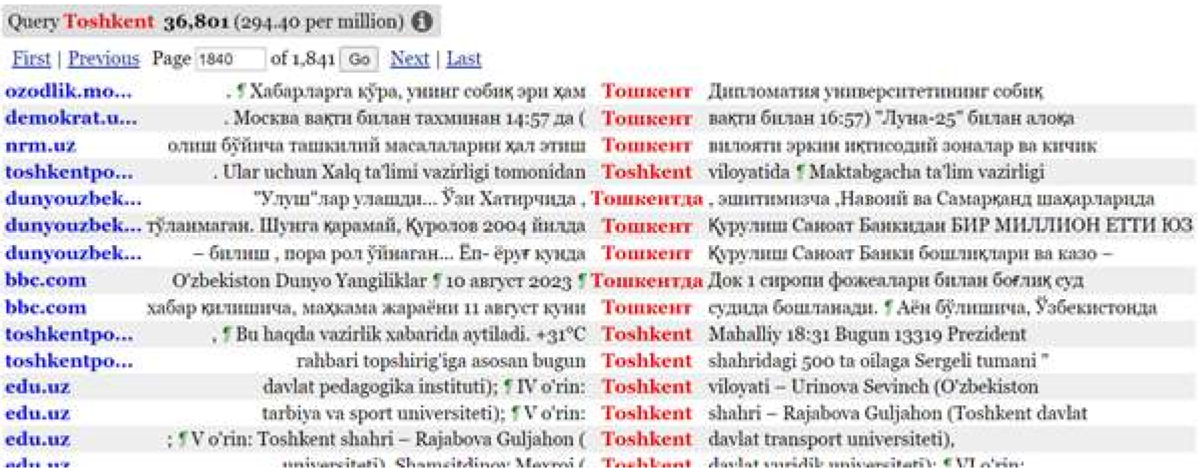
Fig. 2. Normalized (Romanized) and filtered sentence to be sent as input for *Apertium*

```
<>
^Yangi/yangi<n><nom>$
^strategiyani/strategiya<n><acc>$
^avgust/*avgust$
^oyiga/oy<n><px3sp><dat>$
^qadar/qadar<post>$
^Toshkent/Toshkent<np><top><nom>$
^shahri/shahr<n><px3sp><nom>$
^miqesida/ miqyos<n><px3sp><loc>$
^tasdiqlanishi/tasdiqlan<v><iv>
   <ger_abst><px3sp><nom>$
^rejalashtirilmoqda/rejalashtir<v><tv>
   <pass><prog_inf><p3><pl>$
<>
^./.<sent>$
<>
```

Fig. 3. Sentence tagged by *Apertium* in its internal format

TABLE I. FULLY POS TAGGED AND LEMMATIZED SENTENCE

Word	nword	lemma	atag	tag	ztag
<s>					
Янги	Yangi	yangi	Nn	n:nom	1
стратегияни	strategiyani	strategiya	Nn	n:acc	1
август	avgust	avgust	Yy	*	0
ойига	oyiga	oy	Nn	n:px3sp:dat	1
қадар	qadar	qadar	Pp	post	1
Тошкент	Toshkent	Toshkent	Nn	np:top:nom	1
шаҳри	shahri	shahr	Nn	n:px3sp:nom	1
миқёсида	miqyosida	miqyos	Nn	n:px3sp:loc	1
тасдиқланиши	tasdiqlanishi	tasdiqlan	Vb	v:iv:ger_abst:px3sp:nom	1
режалаштирилмоқда	rejalashtirilmoqda	rejalashtir	Vb	v:tv:pass:prog_inf:p3:pl	1
<g/>					
.	.	.	Zz	sent	1
</s>					



Query Toshkent 36,801 (294.40 per million)

First | Previous Page 1840 of 1,841 Go Next | Last

ozodlik.mo...	. ¶ Хабарларга кўра, унинг собиқ эри ҳам	Тошкент	Дипломатия университетининг собиқ
demokrat.u...	. Москва вақти билан тахминан 14:57 да (	Тошкент	вақти билан 16:57) "Луна-25" билан алоқа
nrm.uz	олиш бўйича ташкилий масалаларини ҳал этиш	Тошкент	вилояти эркин иқтисодий зоналар ва кичик
toshkentpo...	. Ular uchun Xalq ta'limi vazirligi tomonidan	Toshkent	viloyatida ¶ Maktabgacha ta'lim vazirligi
dunyouzbek...	"Улуш"лар улашди... Ўзи Хатирчида ,	Тошкентда	, эшитимизча ,Навоий ва Самарқанд шаҳарларида
dunyouzbek...	тўланмаган. Шунга қарамай, Қуролов 2004 йилда	Тошкент	Қурулиш Саноат Банкидан БИР МИЛЛИОН ЕТТИ ЮЗ
dunyouzbek...	– билиш , пора рол ўйнаган... Ёп- ёруғ кунда	Тошкент	Қурулиш Саноат Банки бошлиқлари ва казо –
bbc.com	O'zbekiston Dunyo Yangiliklar ¶ 10 август 2023 ¶	Тошкентда	Док 1 сиропи фожеалари билан боғлиқ суд
bbc.com	хабар қилишича, маҳкама жараёни 11 август куни	Тошкент	судида бошланади. ¶ Аён бўлишича, Ўзбекистонда
toshkentpo...	. ¶ Bu haqda vazirlik xabarida aytiladi. +31°C	Toshkent	Mahalliy 18:31 Bugun 13319 Prezident
toshkentpo...	rahbari topshirig'iga asosan bugun	Toshkent	shahridagi 500 ta oilaga Sergeli tumani "
edu.uz	davlat pedagogika instituti); ¶ IV o'rin:	Toshkent	viloyati – Urinova Sevinch (O'zbekiston
edu.uz	tarbiya va sport universiteti); ¶ V o'rin:	Toshkent	shahri – Rajabova Guljahon (Toshkent davlat
edu.uz	; ¶ V o'rin: Toshkent shahri – Rajabova Guljahon (	Toshkent	davlat transport universiteti).
edu.uz	universiteti). Shamsitdinov Mavrої (	Toshkent	davlat yuridik universiteti); ¶ VI o'rin:

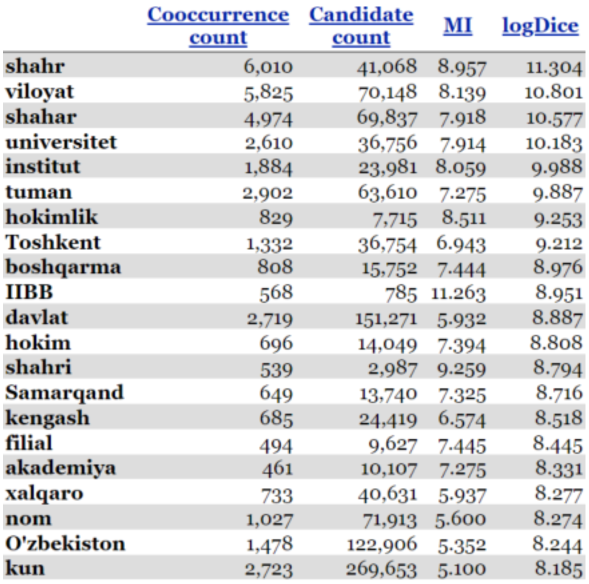
Fig. 4. Querying the Corpus in the “Simple Query” mode

The sentence chosen as an example happened to be in Cyrillic script (Fig. 1), it needed to be converted to Latin script with the XML tags “rasped” so that Apertium would to try to tag them as well (Fig. 2). The Apertium output (Fig. 3) has to be parsed, converted to column format with the original word forms, and XML tags restored to get the format expected by the NoSketch Engine corpus manager (Table I).

The word attribute contains the word form it the original script, nword is its normalized and/or Romanized value, lemma and tag are values assigned by the tagger. Two extra attributes result from the post-PoS processing: atag is the part of speech information expressed in the Araneum Universal Tagset (Anonymous), and ztag displays the result of the morphological lexicon lookup, with the “1” value meaning success, and “0” out of vocabulary (OOV) lexical item. All these corpus attributes are available for querying to corpus users. Moreover, as word, nword, and lemma are present in the “Simple query” CQL definition, user can query either in Latin or Cyrillic script, where queries in Cyrillic script will find Cyrillic occurrences only, while those in Latin script will find occurrences in both scripts, as shown in Fig. 4.

IX. Querying the Corpus

A 125 Megatoken sample of the corpus has already been published at our “Sandbox” Corpora Portal providing the users with full NoSketch Engine functionality. The Fig. 5, for example, shows the most salient collocates of the word “Toshkent” within the “–4 to +5” window sorted by the logDice value.



	Cooccurrence count	Candidate count	MI	logDice
shahr	6,010	41,068	8.957	11.304
viloyat	5,825	70,148	8.139	10.801
shahar	4,974	69,837	7.918	10.577
universitet	2,610	36,756	7.914	10.183
institut	1,884	23,981	8.059	9.988
tuman	2,902	63,610	7.275	9.887
hokimlik	829	7,715	8.511	9.253
Toshkent	1,332	36,754	6.943	9.212
boshqarma	808	15,752	7.444	8.976
IIBB	568	785	11.263	8.951
davlat	2,719	151,271	5.932	8.887
hokim	696	14,049	7.394	8.808
shahri	539	2,987	9.259	8.794
Samarqand	649	13,740	7.325	8.716
kengash	685	24,419	6.574	8.518
filial	494	9,627	7.445	8.445
akademiya	461	10,107	7.275	8.331
xalqaro	733	40,631	5.937	8.277
nom	1,027	71,913	5.600	8.274
O'zbekiston	1,478	122,906	5.352	8.244
kun	2,723	269,653	5.100	8.185

Fig. 5. Most salient collocates of “Toshkent”.

X. Word Embeddings

Word embeddings is a method that assigns multidimensional vectors to individual words. Pioneered by the word2vec, it soon became an indispensable part of many NLP applications. Although nowadays mostly replaced by contextual embeddings, word embeddings are still used for many purposes (e.g in lexicography), because they capture semantic and grammatical properties of individual words.

We provide vector embeddings models for most of the languages of the Aranea family of corpora, the newest addition is the set of Uzbek embeddings trained on the Araneum Uzbecicum corpus with the GenSIM framework. The models use a context window 7 words wide and the skip-gram training algorithm, with dimensionality 200.

The model is accessible through a user-friendly web interface[9] that can be used to access and query the models and demonstrate several common ways of using the models. The interface is built upon an assumption that the vectors reflect semantic properties of the words and the position (and distance) of the vectors in the embedding space corresponds to the position in an abstract “semantic space” of the language. The interface is geared towards lexicographers and linguists without experience in NLP. The models use automatic detection of bigrams, these are treated as regular words (i.e. a vector is assigned to them) and can be used in queries, with the underscore character _ (U+005F LOW LINE) joining the components of the bigram.

The basic information provided is the list of words corresponding to vectors with small angular distance from the given word. Instead of cosine similarity, we define “semantic difference” as √(1–cos2 θ) = sin θ, being close to zero for near-synonyms and close to one for unrelated words. We found out this better aligns with the expectation of our users. An example of the list of near synonyms is at Fig. X2. Then there is a visualization of the embedding vectors, we are using ISOMAP dimensionality reduction to display the results as a 2-dimensional, 3-dimensional or (for those users able to mentally imagine four-dimensional Euclidean space) 4-dimensional map, presented as a perspective projection into 2-dimensional picture, as well as two different word cloud representations. There is also a link to a raw dimensionality reduced data in Gnuplot forma, giving the users ability to pan, zoom and rotate the graphs, or use the data in other statistical software.

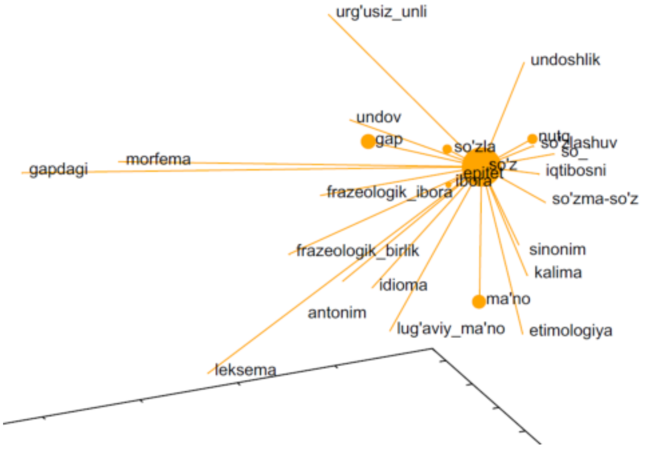
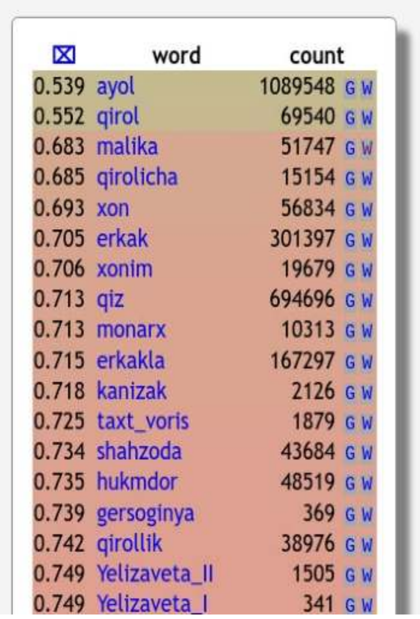


Fig. 6. Three dimensional visualization of word embedding vectors, in the vicinity of the lemma *so'z*.

[9] https://www.juls.savba.sk/semä/?lang=uz

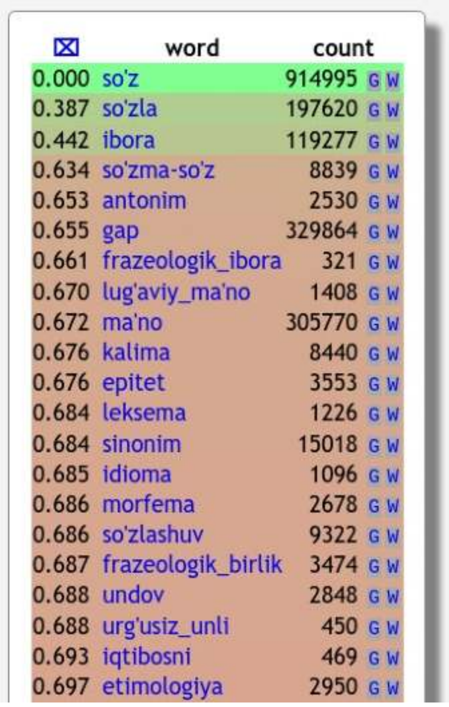
There are three different models available: the model trained on the combination of part of speech and lemmas, the model trained on word forms, and a FastText model The models are also provided as downloadable datasets in text GenSim format.



☒	word	count	
0.539	ayol	1089548	G W
0.552	qirol	69540	G W
0.683	malika	51747	G W
0.685	qirolicha	15154	G W
0.693	xon	56834	G W
0.705	erkak	301397	G W
0.706	xonim	19679	G W
0.713	qiz	694696	G W
0.713	monarx	10313	G W
0.715	erkakla	167297	G W
0.718	kanizak	2126	G W
0.725	taxt_voris	1879	G W
0.734	shahzoda	43684	G W
0.735	hukmdor	48519	G W
0.739	gersoginya	369	G W
0.742	qirollik	38976	G W
0.749	Yelizaveta_II	1505	G W
0.749	Yelizaveta_I	341	G W

Fig. 8. List of nearest vectors to the result of an arithmetic expression qirol – er + ayol.

The links to external resources are (together with the hyperlink symbols): link to the Aranem Uzbecicum Minus corpus; link to the Google search for the word, restricted to the *.uz* top level domain; link to English language Wiktionary entry for the word. This allows quick verification of the usage of the word, mostly for lexicographic purposes.



☒	word	count	
0.000	so'z	914995	G W
0.387	so'zla	197620	G W
0.442	ibora	119277	G W
0.634	so'zma-so'z	8839	G W
0.653	antonim	2530	G W
0.655	gap	329864	G W
0.661	frazeologik_ibora	321	G W
0.670	lug'aviy_ma'no	1408	G W
0.672	ma'no	305770	G W
0.676	kalima	8440	G W
0.676	epitet	3553	G W
0.684	leksema	1226	G W
0.684	sinonim	15018	G W
0.685	idioma	1096	G W
0.686	morfema	2678	G W
0.686	so'zlashuv	9322	G W
0.687	frazeologik_birlik	3474	G W
0.688	undov	2848	G W
0.688	urg'usiz_unli	450	G W
0.693	iqtibosni	469	G W
0.697	etimologiya	2950	G W

Fig. 7. List of nearest vectors to the lemma *so'z*. The columns contain sine similarity, lemma, absolute frequency in the corpus, link to the *Araneum Uzbecicum Minus* corpus, link to Google Search, link to Wiktionary.

The interface supports two other modes of operation: if there are two words (separated by a space) in the input, it displays the sine similarity between them.

The other mode gives access to a basic vector arithmetics, supporting addition and subtraction. This allows easy evaluation of the well known vector transfer (the famous king – man + woman = queen example, see [14] with many applications in linguistic and sociolinguistic research. In Fig. 8. We provide an Uzbek equivalent, the nearest vectors to the expression qirol - er + ayol correspond to the words malika and qirolicha, meeting our expectations.

XI. Conclusion and Further Work

Based on the feedback of the early users, we would like to perform further processing in the foreseeable future as follows:

• As the corpus contains some amount of non-Uzbek (Mostly English and Russian) text fragments, a sentence-level language filtration using the methodology suggested by [28] will be applied.

• Sketch and term grammars for the Sketch Engine will be crated.

• Based on the Apertium morphological lexicon, we'll try to train rules for the CSTlemma lemmatizer, so that lemmas for the OOV lexical items could be guessed.

Besides the availability of our new corpus for on-line querying at our Corpus Portal, we can also provide the processed corpus source data (for non-commercial purposes) under an open license. We hope this this might improve the situation with availability of large-scale language resources for the Uzbek language.

The full Gigaword version of the new corpus will be published on-line in a foreseeable future.

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