Modeling of Models and Processes that Differentiate Semantically Polyfunctional Words in the Context of the Uzbek Language

Article · August 2024

CITATIONS
0

READS
64

5 authors, including:

Botir Boltayeivch Elov
Tashkent State University of Uzbek Language and Literature
163 PUBLICATIONS **88** CITATIONS
SEE PROFILE

Axmedova Xolisa
Tashkent State University of Uzbek Language and Literature named after Alisher …
27 PUBLICATIONS **18** CITATIONS
SEE PROFILE

Oqila Abdullayeva
13 PUBLICATIONS **11** CITATIONS
SEE PROFILE

Lecture Notes in Networks and Systems 1002

Xin-She Yang
Simon Sherratt
Nilanjan Dey
Amit Joshi *Editors*

Proceedings of Ninth International Congress on Information and Communication Technology

ICICT 2024, London, Volume 6

Springer

Lecture Notes in Networks and Systems

Volume 1002

The series "Lecture Notes in Networks and Systems" publishes the latest developments in Networks and Systems—quickly, informally and with high quality. Original research reported in proceedings and post-proceedings represents the core of LNNS.

Volumes published in LNNS embrace all aspects and subfields of, as well as new challenges in, Networks and Systems.

The series contains proceedings and edited volumes in systems and networks, spanning the areas of Cyber-Physical Systems, Autonomous Systems, Sensor Networks, Control Systems, Energy Systems, Automotive Systems, Biological Systems, Vehicular Networking and Connected Vehicles, Aerospace Systems, Automation, Manufacturing, Smart Grids, Nonlinear Systems, Power Systems, Robotics, Social Systems, Economic Systems and other. Of particular value to both the contributors and the readership are the short publication timeframe and the world-wide distribution and exposure which enable both a wide and rapid dissemination of research output.

The series covers the theory, applications, and perspectives on the state of the art and future developments relevant to systems and networks, decision making, control, complex processes and related areas, as embedded in the fields of interdisciplinary and applied sciences, engineering, computer science, physics, economics, social, and life sciences, as well as the paradigms and methodologies behind them.

Indexed by SCOPUS, EI Compendex, INSPEC, WTI Frankfurt eG, zbMATH, SCImago.

All books published in the series are submitted for consideration in Web of Science.

For proposals from Asia please contact Aninda Bose (aninda.bose@springer.com).

Xin-She Yang · Simon Sherratt · Nilanjan Dey · Amit Joshi
Editors

Proceedings of Ninth International Congress on Information and Communication Technology

ICICT 2024, London, Volume 6

Springer

Editors
Xin-She Yang
Middlesex University
London, UK

Simon Sherratt
University of Reading
Reading, UK

Nilanjan Dey
Department of Computer Science
and Engineering
Techno International New Town
Kolkata, West Bengal, India

Amit Joshi
Global Knowledge Research Foundation
Ahmedabad, Gujarat, India

ISSN 2367-3370 ISSN 2367-3389 (electronic)
Lecture Notes in Networks and Systems
ISBN 978-981-97-3298-2 ISBN 978-981-97-3299-9 (eBook)
https://doi.org/10.1007/978-981-97-3299-9

Preface

The Ninth International Congress on Information and Communication Technology will be held from February 19 to 22, 2024, in a hybrid mode, physical in London, UK, and digital platform: Zoom. ICICT 2024 is organized by the Global Knowledge Research Foundation and managed by G. R. Scholastic LLP. The associated partners were Springer and Springer Nature. The conference will provide a useful and wide platform both for display of the latest research and for exchange of research results and thoughts. The participants of the conference will be from almost every part of the world, with backgrounds of either academia or industry, allowing a real multinational multicultural exchange of experiences and ideas.

A great pool of more than 2400 papers was received for this conference from across 129 countries among which around 485 papers were accepted and will be presented physically in London and digital platform Zoom during the four days. Due to the overwhelming response, we had to drop many papers in the hierarchy of the quality. A total of 70 technical sessions will be organized in parallel in four days along with a few keynotes and panel discussions in hybrid mode. The conference will be involved in deep discussion and issues which will be intended to solve at global levels. New technologies will be proposed, experiences will be shared, and future solutions for design infrastructure for ICT will also be discussed. The final papers will be published in ten volumes of proceedings by Springer LNNS Series. Over the years, this congress has been organized and conceptualized with the collective efforts of a large number of

individuals. I would like to thank each of the committee members and the reviewers for their excellent work in reviewing the papers. Grateful acknowledgments are extended to the team of Global Knowledge Research Foundation for their valuable efforts and support.

I look forward to welcoming you to the 10th Edition of this ICICT Congress 2025.

Amit Joshi, Ph.D.
Organising Secretary, ICICT 2024
Director—Global Knowledge Research Foundation
Ahmedabad, India

Contents

Editors and Contributors

About the Editors

Xin-She Yang obtained his D.Phil. in Applied Mathematics from the University of Oxford and subsequently worked at the Cambridge University and the National Physical Laboratory (UK) as a Senior Research Scientist. He is currently Reader in Modeling and Optimization at Middlesex University London and Adjunct Professor at Reykjavik University (Iceland). He is also elected Bye-Fellow at Cambridge University and the IEEE CIS Chair for the Task Force on Business Intelligence and Knowledge Management. He was included in the "2016 Thomson Reuters Highly Cited Researchers" list.

Simon Sherratt was born near Liverpool, England, in 1969. He is currently Professor of Biosensors at the Department of Biomedical Engineering, University of Reading, UK. His main research area is signal processing and personal communications in consumer devices, focusing on wearable devices and health care. He received the first place IEEE Chester Sall Memorial Award in 2006, the second place in 2016, and the third place in 2017.

Nilanjan Dey is Assistant Professor at the Department of Information Technology, Techno India College of Technology, India. He has authored/edited more than 75 books with Springer, Elsevier, Wiley, and CRC Press and published more than 300 peer-reviewed research papers. He is Editor-in-Chief of the *International Journal of Ambient Computing and Intelligence*; Series Co-editor of *Springer Tracts in Nature-Inspired Computing* (STNIC); and Series Co-editor of *Advances in Ubiquitous Sensing Applications for Healthcare*, Elsevier.

Amit Joshi is Director of Global Knowledge Research Foundation, and also Entrepreneur and Researcher who has completed his masters' and research in the areas of cloud computing and cryptography in medical imaging. He has an experience of around ten years in academics and industry in prestigious organizations.

He is Active Member of ACM, IEEE, CSI, AMIE, IACSIT-Singapore, IDES, ACEEE, NPA, and many other professional societies. He is the International Chair of InterYIT at the International Federation of Information Processing. He has presented and published more than 50 papers in national and international journals/conferences of IEEE and ACM. He has also edited more than 40 books which are published by Springer, ACM, and other reputed publishers. He has also organized more than 50 national and international conferences and programs in association with ACM, Springer, and IEEE to name a few across different countries including India, UK, Europe, USA, Canada, Thailand, Egypt, and many more.

Contributors

Jenerry Y. Abad Department of Computer Studies, Cavite State University-CCAT Campus, Rosario, Cavite, Philippines

Mohammad Abdallah Al-Zaytoonah University of Jordan, Amman, Jordan

Raghad K. Abdulhassan College of Education for Women, University of Baghdad, Baghdad, Iraq

Noreddine Abghour Mathematics and Computing Department, LIS Labs Faculty of Sciences Ain Chock, Hassan II University of Casablanca, Casablanca, Morocco

Andi Jusdiana Ahmad Universitas Muhammadiyah Makassar, Makassar, Indonesia

Mohamed Ajaamoum Laboratory of Engineering Science and Energy Management (LASIME), Higher School of Technology (EST), Ibn Zohr University, Agadir, Morocco

Temidayo Akenroye University of South Africa, Pretoria, RSA; University of Missouri-St. Louis, St. Louis, MO, USA

Omololu Akin-Ojo African Center of Excellence in the Internet of Things, College of Science and Technology, University of Rwanda, Kigali, Rwanda

Mariam Akter Department of Computer Science and Engineering, Feni University, Feni, Bangladesh

Sulaiman Abdullah Alateyah Department of Computer Science, College of Science and Arts, Qassim University, Unaizah, Saudi Arabia

Oleg Alienin National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, Kyiv, Ukraine

Asmaa Abdul-Razzaq Al-Qaisi College of Education for Women, University of Baghdad, Baghdad, Iraq

Teodora Angelova Agricultural Institute Agricultural Academy, Stara Zagora, Bulgaria

Rifat Sarker Aoyon Brac University, Dhaka, Bangladesh

Senta Ariizumi University of Yamanashi, Kofu Yamanashi, Japan

Maroun Abi Assaf Holy Spirit University of Kaslik, Jounieh, Lebanon

Pouya Ataei Auckland University of Technology, Auckland, New Zealand

Marwane Ayaida Université Polytechnique, Hauts-de-France, Valenciennes, France

Sulafa M. Badi Faculty of Business and Law, The British University in Dubai (BUiD), Dubai, United Arab Emirates

Danylo Baran National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

Abdelmalek Bengheni Department of Science Computer, Ibn Khaldoun University, Tiaret, Algeria

Klaus Bengler School of Engineering and Design, Chair of Ergonomics, Technical University of Munich, Garching, b. Munich, Germany

Pravin Kumar Bhoyar Symbiosis Institute of Management Studies (SIMS), A Constituent of Symbiosis International Deemed University, Pune, India

Zephanie Bizimana African Center of Excellence in the Internet of Things, College of Science and Technology, University of Rwanda, Kigali, Rwanda; Rwanda Polytechnic-Integrated Polytechnic Regional College of Karongi, Karongi, Rwanda

Yamlak Bogale College of Engineering, Carnegie Mellon University Africa, Kigali, Rwanda

Mónica Bolaños-Pasquel Facultad de Psicología, Centro de Investigación en Mecatrónica y Sistemas Interactivos—MIST, Universidad Tecnológica Indoamérica, Quito, Ecuador

Elov Botir Boltayevich Tashkent State University named after Alisher Navoi University of Uzbek Language and Literature, Tashkent, Uzbekistan; Technical Science Tashkent State University of Uzbek Language and Literature named after Alisher Navo'i Tashkent, Tashkent, Uzbekistan

Brahim Bouachrine Laboratory of Engineering Science and Energy Management (LASIME), Higher School of Technology (EST), Ibn Zohr University, Agadir, Morocco

Adda Boualem Department of Science Computer, Ibn Khaldoun University, Tiaret, Algeria

Shayma Boukari LARODEC Laboratory, ISG, University of Tunis, Tunis, Tunisia

El-Mahfoud Boulaoutaq Laboratory of Engineering Science and Energy Management (LASIME), Higher School of Technology (EST), Ibn Zohr University, Agadir, Morocco

Zouhair Chiba Mathematics and Computing Department, LIS Labs Faculty of Sciences Ain Chock, Hassan II University of Casablanca, Casablanca, Morocco

Pradnya Vishwas Chitrao Symbiosis Institute of Management Studies (SIMS), A Constituent of Symbiosis International Deemed University, Pune, India

Nayden Chivarov Institute of Information and Communication Technologies, Bulgarian Academy of Sciences, Sofia, Bulgaria

Hong-fu Chou Interdisciplinary Centre for Security, Reliability, and Trust, University of Luxembourg, Belval, Luxembourg

Muntasir Karim Chowdhury Department of Computer Science and Engineering, Feni University, Feni, Bangladesh

Bang Bui Cong FPT University, Ho Chi Minh City, Viet Nam

Thanh N. N. Cong Institute of Research and Development, Duy Tan University, Da Nang City, Vietnam

Jorge Cruz-Cárdenas School of Administrative and Economic Science, Research Center in Business, Society, and Technology, ESTec, Universidad Tecnológica Indoamérica, Quito, Ecuador

Christian Daase Otto-von-Guericke University Magdeburg, Magdeburg, Germany

Kaoutar Dahmane Laboratory of Engineering Science and Energy Management (LASIME), Higher School of Technology (EST), Ibn Zohr University, Agadir, Morocco

Cyril De Runz University of Tours, LIFAT, Blois, France

Vu Thu Diep HaNoi University of Science and Technology, Hanoi, Vietnam

Rajiv Divekar Symbiosis Institute of Management Studies (SIMS), A Constituent of Symbiosis International Deemed University, Pune, India

Assad Souleyman Doutoum Department of Computer Engineering, Ankara University, Ankara, Turkey

Varun Dutt ACS Lab, Indian Institute of Technology Mandi, Mandi, Himachal Pradesh, India

Recep Eryigit Department of Computer Engineering, Ankara University, Ankara, Turkey

Rim Faiz LARODEC Laboratory, ISG, University of Tunis, Tunis, Tunisia

Charbel Fares Holy Spirit University of Kaslik, Jounieh, Lebanon

Kholmukhamedov Bakhtiyor Farkhodovich Samarkand State University named after Sharof Rashidov, Samarkand, Uzbekistan

Agnieszka Gajewska University of the National Education Commission, Krakow, Krakow, Poland

Andrei P. Gantimurov Artificial Intelligence Technology Scientific and Education Center, Bauman Moscow State Technical University, Moscow, Russia

Patricia García-Cruz Facultad de Psicología, Pontificia Universidad Católica del Ecuador, Quito, Ecuador

Christos K. Georgiadis University of Macedonia, Thessaloniki, Greece

Antonios Giatzis University of Macedonia, Thessaloniki, Greece

Yuri Gordienko National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

Yogesh Gupta School of Engineering and Technology, BML Munjal University, Gurugram, India

S. Gurunarayanan Birla Institute of Technology and Science, Pilani, Hyderabad, Telangana, India

Joseph Habiyaremye Narada Electronics, Kigali, Rwanda

Christian Haertel Otto-von-Guericke University Magdeburg, Magdeburg, Germany

Primova Mastura Hakim qizi Department of Computational Linguistics and Digital Technologies, Tashkent State University of Uzbek Language and Literature named after Alisher Navo'i Tashkent, Tashkent, Uzbekistan

Sangwook Han Gachon University, Seongnam-si, South Korea

Damien Hanyurwimfura ACEIoT, College of Science and Technology, University of Rwanda, Kigali, Rwanda

Md. Hasnat Ali BITS Pilani, Hyderabad, India;
LV Prasad Eye Institute, Hyderabad, India

Herman Universitas Muhammadiyah Makassar, Makassar, Indonesia

Ismail Hossain George Mason University, Fairfax, VA, USA

Phan Duy Hung FPT University, Hanoi, Vietnam

Axmedova Xolisxon Ilxomovna Tashkent State University named after Alisher Navoi University of Uzbek Language and Literature, Tashkent, Uzbekistan

Belkasem Imodane Laboratory of Engineering Science and Energy Management (LASIME), Higher School of Technology (EST), Ibn Zohr University, Agadir, Morocco

Mustafa Musa Jaber Informatics Institute for Postgraduate Studies, Iraqi Commission for Computers and Informatics, Baghdad, Iraq

Busrat Jahan Department of Computer Science and Engineering, Feni University, Feni, Bangladesh

Enas Muzaffer Jamel College of Education for Women, University of Baghdad, Baghdad, Iraq

N. K. Jisy BITS Pilani, Hyderabad, India

Jaco Jordaan Tshwane University of Technology, eMalahleni Campus, Emalahleni, South Africa

Junaedi Universitas Muhammadiyah Makassar, Makassar, Indonesia

Alain Destin Nishimwe Karasira College of Engineering, Carnegie Mellon University Africa, Kigali, Rwanda

Thashmee Karunaratne Stockholm University, Kista, Sweden

Anupama Karuppiah Birla Institute of Technology and Science, Pilani, Goa, India

AbdulSattar M. Khidhir Department of Electronics Technologies, Mosul Technical Institute, Northern Technical University, Mosul, Iraq

Hisham Kholidy Polytechnic Institute, College of Engineering, State University of New York, New York, USA

Chun Hyok Kim Huichon University of Technology, Huichon, Democratic People's Republic of Korea

Yuriy Kochura National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

Tetiana Konrad National Aviation University, Kyiv, Ukraine

Zhivko Krastanov Agricultural Institute Agricultural Academy, Stara Zagora, Bulgaria

Kirill I. Kravtsov Reshetnev Siberian State University of Science and Technology, Krasnoyarsk, Russia

Tatsuki Kubota University of Yamanashi, Kofu Yamanashi, Japan

Praveen Kumar ACS Lab, Indian Institute of Technology Mandi, Mandi, Himachal Pradesh, India

Santhi Kumaran School of ICT, Copperbelt University, Kitwe, Zambia

Georgia Lamni University of Macedonia, Thessaloniki, Greece

Erik Lautenschläger IU International University of Applied Sciences, Bad Honnef, Germany

Oumaima Lifandali Mathematics and Computing Department, LIS Labs Faculty of Sciences Ain Chock, Hassan II University of Casablanca, Casablanca, Morocco

Mohammad Gulam Lorgat Universidade Católica de Moçambique, Chimoio, Manica, Mozambique;
INESC TEC, Porto, Portugal

Sean Longyu Ma School of Computer Science, The University of Auckland, Auckland, New Zealand

Emmanuel Masabo African Center of Excellence in the Internet of Things, College of Science and Technology, University of Rwanda, Kigali, Rwanda

Fannie Isaac Masango Tshwane University of Technology, eMalahleni Campus, Emalahleni, South Africa

Shazzad Hossain Mazumder Department of Computer Science and Engineering, Feni University, Feni, Bangladesh

Naomi Y. Mbelekani School of Engineering and Design, Chair of Ergonomics, Technical University of Munich, Garching, b. Munich, Germany

Anton S. Mikhalev Siberian Federal University, Krasnoyarsk, Russia

S. M. Mizanoor Rahman The Pennsylvania State University, Dunmore, PA, USA

Marcia Mkansi University of South Africa, Pretoria, RSA

P. Y. Mok School of Fashion and Textiles, The Hong Kong Polytechnic University, Hong Kong, China

Thapelo Mokole University of South Africa, Pretoria, RSA

Carine Pierette Mukamakuza College of Engineering, Carnegie Mellon University Africa, Kigali, Rwanda

Didacienne Mukanyiligira ACEIoT, College of Science and Technology, University of Rwanda, Kigali, Rwanda;
National Council for Science and Technology, Kigali, Rwanda

A. M. Mukhanova Almaty University of Technology, Almaty, Republic of Kazakhstan

Nuryanti Mustari Universitas Muhammadiyah Makassar, Makassar, Indonesia

Allen Jhon C. Muyot Department of Computer Studies, Cavite State University-CCAT Campus, Rosario, Cavite, Philippines

Karlo Jose E. Nabablit Department of Computer Studies, Cavite State University-CCAT Campus, Rosario, Cavite, Philippines

Taymoor Mohamed Nazmy Department of Computer Science, Faculty of Computer and Information Science, AinShams University, Cairo, Egypt

Vladimir A. Nelyub Artificial Intelligence Technology Scientific and Education Center, Bauman Moscow State Technical University, Moscow, Russia; Far Eastern Federal University, Vladivostok, Russia

Desire Ngabo African Center of Excellence in the Internet of Things, College of Science and Technology, University of Rwanda, Kigali, Rwanda

Phan Thanh Ngoc VNU University of Engineering and Technology, Hanoi, Vietnam

Ephrem Niyigaba Rwanda Polytechnic-Integrated Polytechnic Regional College of Karongi, Karongi, Rwanda

Agha Francis Nnachi Tshwane University of Technology, eMalahleni Campus, Emalahleni, South Africa

Henryk Noga University of the National Education Commission, Krakow, Krakow, Poland

Mark Edriane F. Nolledo Department of Computer Studies, Cavite State University-CCAT Campus, Rosario, Cavite, Philippines

Elias Ntawuzumunsi ACEIoT, College of Science and Technology, University of Rwanda, Kigali, Rwanda

Kenji Ozawa University of Yamanashi, Kofu Yamanashi, Japan

Se Hun Pak Kim Cheak University of Technology, Pyongyang, Democratic People's Republic of Korea

Peter Panev Institute of Information and Communication Technologies, Bulgarian Academy of Sciences, Sofia, Bulgaria

Teodora Petrova Agricultural Institute Agricultural Academy, Stara Zagora, Bulgaria

Rosen Petrov Institute of Information and Communication Technologies, Bulgarian Academy of Sciences, Sofia, Bulgaria

Matthias Pohl Otto-von-Guericke University Magdeburg, Magdeburg, Germany

P. Priyanka ACS Lab, Indian Institute of Technology Mandi, Mandi, Himachal Pradesh, India

Oleksii Pysarchuk National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

Minhao Qiao School of Fashion and Textiles, The Hong Kong Polytechnic University, Hong Kong, China

Ali Rachini Holy Spirit University of Kaslik, Jounieh, Lebanon

Mohammad Abdur Rahman Department of Computer Science and Engineering, Feni University, Feni, Bangladesh

Valentina Ramos Sistemas de Información, Gestión de la Tecnología e Innovación (SIGTI-Research Group), Escuela Politécnica Nacional, Quito, Ecuador

Carlos Ramos-Galarza Facultad de Psicología, Centro de Investigación en Mecatrónica y Sistemas Interactivos—MIST, Universidad Tecnológica Indoamérica, Quito, Ecuador;
Facultad de Psicología, Pontificia Universidad Católica del Ecuador, Quito, Ecuador

Jamoldinova Odinaxon Rasulovna Social Sciences and Humanities Department Alisher Navo'i, Tashkent State University of Uzbek Language and Literature, Tashkent, Uzbekistan

Aloyev Narzillo Raxmatilloyevich Department of Computer Linguistics and Digital Technology, Tashkent State University of Uzbek Language and Literature named after Alisher Navo'i Tashkent, Tashkent, Uzbekistan

Muhammad Abu Rayan Department of Computer Science and Engineering, Feni University, Feni, Bangladesh

Lilia Raycheva The St. Kliment Ohridski Sofia University, Sofia, Bulgaria

Rosdianti Razak Universitas Muhammadiyah Makassar, Makassar, Indonesia

Man Gun Ri Kim Cheak University of Technology, Pyongyang, Democratic People's Republic of Korea

Thorben Rohde Otto-von-Guericke University Magdeburg, Magdeburg, Germany

Oleksandr Rokovyi National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

André Manuel Saene Universidade Católica de Moçambique, Chimoio, Manica, Mozambique

Sirisha Senthil LV Prasad Eye Institute, Hyderabad, India

Pawan Sharma Birla Institute of Technology and Science, Pilani, Pilani, India

D. Shevchuk National Aviation University, Kyiv, Ukraine

Maksym Shulha National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

Louis Sibomana ACEIoT, College of Science and Technology, University of Rwanda, Kigali, Rwanda;
National Council for Science and Technology, Kigali, Rwanda

A. B. Sinchev National Information Technologies JSC, Astana, Republic of Kazakhstan

B. Sinchev International University of Information Technology, Almaty, Republic of Kazakhstan

M. B. Srinivas BITS Pilani, Dubai, UAE

Daniel Staegemann Otto-von-Guericke University Magdeburg, Magdeburg, Germany

I. Steniakin National Aviation University, Kyiv, Ukraine

Sergii Stirenko National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

Djahida Taibi Department of Science Computer, Ibn Khaldoun University, Tiaret, Algeria

Vladyslav Taran National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

Nguyen Quang Thang FPT University, Hanoi, Vietnam

Hoa Doan Nguyen Thanh Department of Computer Science, VSB-Technical University of Ostrava, Ostrava-Poruba, Czech Republic

Hiep. L. Thi Faculty of Education, Thu Dau Mot University, Thu Dau Mot City, Binh Duong, Vietnam

Phu Nguyen Ngoc Thien FPT University, Ho Chi Minh City, Viet Nam

Teruki Toya University of Yamanashi, Kofu Yamanashi, Japan

Bulent Tugrul Department of Computer Engineering, Ankara University, Ankara, Turkey

Klaus Turowski Otto-von-Guericke University Magdeburg, Magdeburg, Germany

Abdurahmonova Muqaddas Tursunalievna Tashkent State University named after Alisher Navoi University of Uzbek Language and Literature, Tashkent, Uzbekistan

Emmanuel Tuyishimire Academy of Computer Science and Software Engineering, University of Johannesburg, Johannesburg, South Africa;
College of Science and Technology, University of Rwanda, Kigali, Rwanda

Vadim S. Tynchenko Artificial Intelligence Technology Scientific and Education Center, Bauman Moscow State Technical University, Moscow, Russia; Information-Control Systems Department, Institute of Computer Science and Telecommunications, Reshetnev Siberian State University of Science and Technology, Krasnoyarsk, Russia

K. V. Uday Geotechnical Engineering Lab, Indian Institute of Technology Mandi, Mandi, Himachal Pradesh, India

Khudayberganov Nizomaddin Uktambay o'g'li Department of Computational Linguistics and Digital Technologies, Tashkent State University of Uzbek Language and Literature named after Alisher Navo'i Tashkent, Tashkent, Uzbekistan

Marie Ritha Umutoni ACEIoT, College of Science and Technology, University of Rwanda, Kigali, Rwanda

Nguyen Hong Van FPT University, Hanoi, Vietnam

Maria Socorro D. Victa Department of Computer Studies, Cavite State University-CCAT Campus, Rosario, Cavite, Philippines

Matthias Volk Otto-von-Guericke University Magdeburg, Magdeburg, Germany

Viktoriya Volkogon National Aviation University, Kyiv, Ukraine

Shih-Shuan Wang Transilvania University of Brasov, Brasov, Romania

Abdullayeva Oqila Xolmo'minovna Tashkent State University named after Alisher Navoi University of Uzbek Language and Literature, Tashkent, Uzbekistan

Stanislav Yovkov Institute of Information and Communication Technologies, Bulgarian Academy of Sciences, Sofia, Bulgaria

Xusainova Zilola Yuldashevna Computer Linguistics and Digital Technology, Tashkent State University of Uzbek Language and Literature named after Alisher Navo'i Tashkent, Tashkent, Uzbekistan

Xinchao Zhong School of Computer Science, The University of Auckland, Auckland, New Zealand

Slavko Žitnik University of Ljubljana, Ljubljana, Slovenia

Modeling of Models and Processes that Differentiate Semantically Polyfunctional Words in the Context of the Uzbek Language

Elov Botir Boltayevich, Abdurahmonova Muqaddas Tursunalievna, Axmedova Xolisxon Ilxomovna, Abdullayeva Oqila Xolmo'minovna, and Kholmukhamedov Bakhtiyor Farkhodovich

Abstract Another urgent issue of applied linguistics is to create a linguistic filter for semantically distinguishing polyfunctional words, and for the field of computer linguistics, it is an urgent issue to develop mathematical models and algorithms for semantically distinguishing them, as well as an information system. This article discusses the models for semantic differentiation of polyfunctional words in the Uzbek language when they occur in the structure of a sentence. We got acquainted with studies of the Turkic language family. A hierarchy of polyfunctional words in the Uzbek language in terms of word groups has been formed. Mathematical models for semantically differentiating polyfunctional words within the categories noun ∨ adjective, adjective ∨ modal word, adjective ∨ adverb, auxiliary verb ∨ independent verb, and conclusion ∨ auxiliary are presented. The business processes distinguishing the polyfunctionality of the Uzbek language semantic analyzer were modeled, and the conceptual model of the information system, its architecture, and structure were developed. The developed information system is based on the MVT architecture and was developed using the Python programming language. The efficiency of the developed mathematical models was 71.7%.

Keywords Polyfunctional words · Mathematical model · Set · Finite set · Business processes · Modeling · Vocabulary · Conceptual model · Structure and architecture of information system

E. B. Boltayevich (✉) · A. M. Tursunalievna · A. X. Ilxomovna · A. O. Xolmo'minovna
Tashkent State University named after Alisher Navoi University of Uzbek Language and Literature, Tashkent O'qituvchi Street 103, Tashkent, Uzbekistan
e-mail: elov@navoiy-uni.uz

A. M. Tursunalievna
e-mail: abduraxmanovamuqaddas@navoiy-uni.uz

A. O. Xolmo'minovna
e-mail: abdullayeva.oqila@navoiy-uni.uz

K. B. Farkhodovich
Samarkand State University named after Sharof Rashidov, Samarqand Universitet xiyoboni 15, Samarkand, Uzbekistan

X.-S. Yang et al. (eds.), *Proceedings of Ninth International Congress on Information and Communication Technology*, Lecture Notes in Networks and Systems 1002,
https://doi.org/10.1007/978-981-97-3299-9_35

1 Introduction

The problem of polyfunctionality of lexical units is one of the urgent problems of modern linguistics. In world linguistics, the issue of polyfunctional words often occurs in Russian, English, Tatar, and Chinese languages. The concept of polyfunctionality appears in some sources as multi-functionality. In many foreign linguistic works, polyfunctionality is considered in connection with the phenomena of homonymy. One of the main issues in the field of natural language processing is the issue of automatic semantic analysis of words, sentences, and texts. Semantic analysis is very important to Natural Language Processing (NLP) because its processes enable the identification of different meanings of words. In addition, these processes help the machine understand the meaning of whole sentences and texts. There are two typical processes of NLP semantics, which in turn are divided into several groups according to the task they perform:

1. Word sense disambiguation
2. Sentiment analysis.

Word Sense Disambiguation. This term describes the automatic process of determining the context of any word. Thus, the process focuses on analyzing a sample of text to find out the meaning of a word. In natural language, one word often has more than one meaning. For example, the word *kul* can mean *kukun* from a fire, but it can also represent the imperative form of the verb *kulmoq*. The task of the computer is to understand the word in a certain context and choose the best meaning. Computers use inference to perform tasks.

Sentiment Analysis. A sentence often contains several nouns (words or phrases) that are related to each other. The term relationship extraction describes the process of extracting semantic relationships between these objects.

Semantic analysis methods can be seen in Fig. 1.

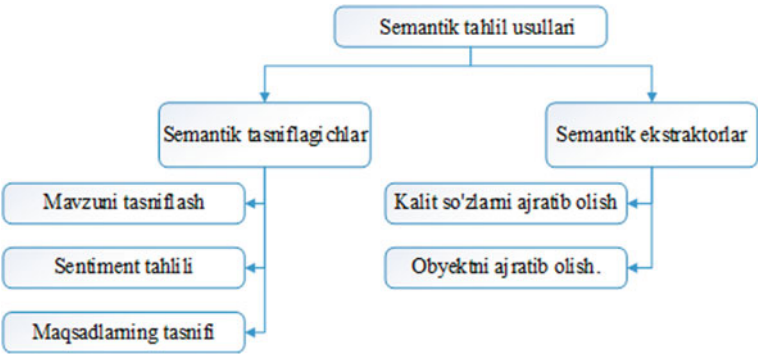

Fig. 1 Types of semantic analysis

Automatic implementation of semantic analysis perfects the operation of the information-search system in the national corpus of the Uzbek language. Determining the semantics of the searched lexical units is one of the main tasks in the field of NLP.

Extracting Keywords. It is a branch of semantic analysis and consists of groups of words that can perform different tasks. Keywords include words such as synonym, homonym, antonym, polysemantic, polyfunctional, meronym. Polyfunctional words are one of these elements and are important in semantic analysis. The word polyfunctional (poly-many, functional-task) is a word that performs many functions. A question may arise here. What tasks can be performed, what is meant by task? Polyfunctional words are words that have the same form and meaning within the same topic. They can be distinguished only by having answers to questions of different word groups in different sentences.

- Saodatxon orziqib javob kutar, Tojiboy aka bo‘lsa, **aniq** javob bermay, gapni aylantirar edi.
- Endi kimga og‘iz solsang, g‘iring demay tegishi **aniq**.

In these sentences, the word “aniq” is a polyfunctional word, in the first sentence it belongs to the adjective group, and in the second sentence it functions as a modal word.

2 Materials and Methods

The problem of polyfunctionality of lexical units is one of the urgent problems of modern linguistics. The issue of polyfunctional words is often found in Russian, English, Tatar, and Chinese languages in world linguistics. The concept of polyfunctionality appears in some sources in the form of multi-functionality. In many foreign linguistic works, polyfunctionality is considered in connection with the phenomena of homonymy [1] (Kolesnikov 1984; Malakhovsky 1990; Lapteva 1999; Starodumova 2002 and others). Linguist Gorina Irina Ivanovna in her article “Lekseman slovna polifunksionalnoye slova sovremennogo russkoga yazyka” defines “Multifunctionality is the ability to switch from one fixed part of a sentence to another.” In his research, I. I. Gorina provided detailed information about other polyfunctional usages of the word slovna in the Russian language [2]. One of the Chinese linguists Xun Hun found the Chinese equivalent of the polyfunctional words in the Russian language and the Russian-Chinese dictionary in his candidate’s thesis and explained their meanings [3]. Examples of polyfunctional words in English are pronouns. O. D. Vishnyakova proved that the modal word -able can be considered as a polyfunctional word with the help of annotations [21]. E. N. Vinogradova separated most of the functions of prepositions in the Russian language [1] and divided them into groups. Tokarchuk, I. N. cited the methods of solving polyfunctionality in the

process of POS tagging of the national corpus of the Russian language [4]. Salvadori, J. spoke about the polyfunctionality of adverbs in the French language, based on the lexical-morphological features of adverbs at night [21].

The issue of polyfunctional words has not been fully resolved in world linguistics, and we have not found any research on its automatic detection, elimination in the corpus, linguistic filter, and P model. In this article, an attempt was made to summarize the existing theoretical views in the Uzbek language and use them to perform preliminary work on the modeling of polyfunctional words for the semantic analyzer. Filters work to model polyfunctional words. It is important to create mathematical models based on the generated filters and linguistic models. Researcher Sh. Gulyamova says, "Linguistic modeling of polyfunctional words should be defined in terms of categories" [5]. He summarized the existing theoretical views on the Uzbek language and carried out initial work on the modeling of polyfunctional words for the semantic analyzer. The researcher identified a total of 21 groups of polyfunctional words in the section of word groups.

3 Main Part

It is necessary to develop a mathematical model of polyfunctional word differentiation for each category. Similar to homonyms, polyfunctional words can be differentiated based on conjunctions, but this method alone is not enough to distinguish all polyfunctional words and create a model. Because some sets of words are determined by the context. Although this is the case, clear laws and models are needed for a system that differentiates polyfunctionality. When Sh. Gulyamova classified in categories, she developed a linguistic model for the polyfunctional words of each group. Based on the created linguistic models, we will develop legal and mathematical models for the system. We introduce a set of generic polyfunctional words such as Pf (Fig. 2). Determining polyfunctionality between noun $\vee$ adjective word groups. We take the word "kasal" as an example of a word that creates polyfunctionality between noun and adjective. Here are some examples of how the word "kasal" is used as a noun in the context and when it is used as an adjective:

1. "O‘g‘lingizning kasali ma’lum bo‘ldi", – debdi Ibn Sino
2. Bahonani oshirishmi yoki kasalni yashirish?!
3. Qo‘shnim kasal sigirini yetaklab qassobxona yo‘l oldi.
4. Palataga og‘ir kasal bemor joylashtirildi.

In sentences 1–2, the word kasal belongs to the noun group. In sentences 3–4, the word kasal is an adjective. In these sentences.

- Kasal+-i/ni/ga/lar/da/ini/. . . aniqlandi/ko‘rmoq/keldi/. . .
- Kasal odam/bemor/hayvon/qush/. . ..

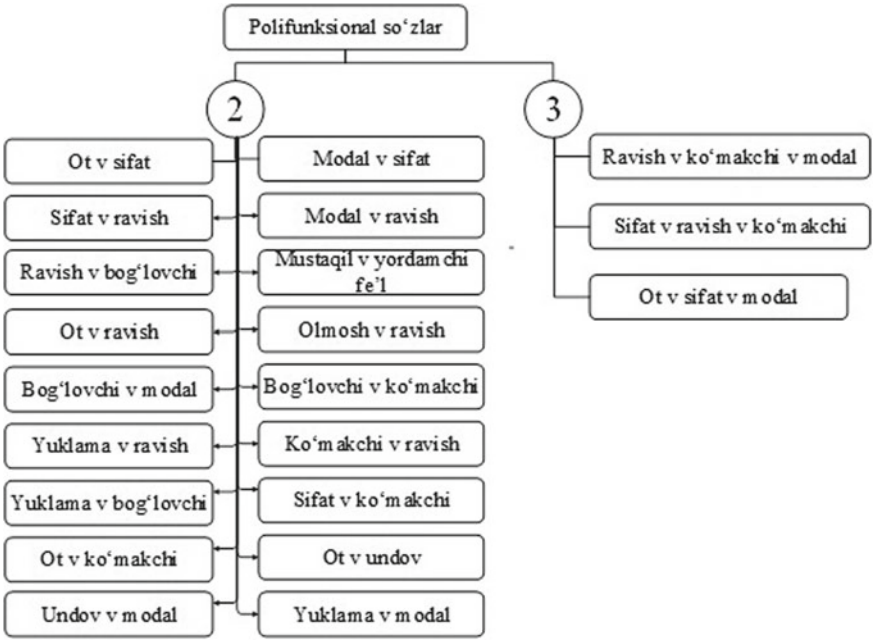

Fig. 2 Cases of meeting polyfunctional words within word groups

Based on these analyses, we conclude

$$\mathrm{Pf}_{\mathrm{Adj},N} = \begin{cases} \mathrm{Pf}^{N}, & \text{if } \mathrm{Pf}^{\mathrm{Adj},N} + \downarrow \mathrm{aff}^{N} \oplus V \\ \mathrm{Pf}^{\mathrm{Adj}}, & \text{if } \mathrm{Pf}^{\mathrm{Adj},N} + \downarrow \mathrm{aff}^{d}eg \oplus N \end{cases} \tag{1}$$

Using (1), we propose to determine the polyfunctionality between noun or adjective. Determining polyfunctionality between adjective $\vee$ modal word groups. We define the mathematical model defining the polyfunctionality between the adjective $\vee$ modal word groups using the exact word and conclude.

Aniq—adjectivet:

1. Saodatxon orziqib javob kutar, Tojiboy aka bo’lsa, aniq javob bermay, gapni aylantirar edi
2. o‘pchilik tomonidan ma’qullangan amaliy, aniq takliflar kiritildi Modal word:
3. Xolmirza aka ichidan “shu g‘ayrating bo‘lsa, ikki yilda Xirmontepadan aniq ayrilamiz”, deb o‘ylaydi.
4. Endi kimga og‘iz solsang, g‘iring demay tegishi aniq.
5. Aniq—modal so‘z, shubhasiz, shaksiz so‘zlari bilan ma’nodosh.

It can be seen from the sentences that after a polyfunctional word, a verb can be found in both cases, and a noun word can be found before it. It follows that it is possible to distinguish polyfunctionality between adjective $\vee$ modal words by forming a list of compounds for this type of words

$$\mathrm{Pf}_{M,\mathrm{Adj}} = \begin{cases} \mathrm{Pf}^{\mathrm{Adj}}, & \text{if } \mathrm{Pf}^{M,\mathrm{Adj}} + \downarrow \mathrm{aff}^{A} dj \oplus W^{\mathrm{Pf}_{A} dj} \\ \mathrm{Pf}^{M}, & \text{if } W^{M} \oplus \mathrm{Pf}^{M,\mathrm{Adj}} + \oplus W^{M} \end{cases} \tag{2}$$

Using the model (2), polyfunctionality between an adjective or a modal word can be determined.

Determining the polyfunctionality between Independent verb and auxiliary verb. We bring the word "**boq**" to the polyfunctional words between adjectives or adverbs: **Boq**—(1) to look. (2) To care for a long time by giving food (verb).
Boq—to the lexical meaning of an independent verb, it adds the grammatical meaning of "execution of an action for the purpose of testing, checking" i (auxiliary verb). Taking into account the above analysis, we present the following mathematical model

$$\mathrm{Pf}_{I,L} = \begin{cases} \mathrm{Pf}^{I}, & \text{if } W^{x} + \mathrm{aff}^{\mathrm{CS}} \oplus \mathrm{Pf}^{I,L} \\ \mathrm{Pf}^{L}, & \text{if } V^{L} + \mathrm{aff}^{L} \oplus \mathrm{Pf}^{I,L} \end{cases} \tag{3}$$

Through this model, it is possible to distinguish between polyfunctional words that can become leading and auxiliary verbs.
Determining the polyfunctionality between adjectives and adverbs Let's consider the analysis of "betartib" words as one of the words that create polyfunctionality between adjective ∨ adverb word groups:

- **betartib**+-roq/-gina odam/xona/uy/ko'cha/
- **betartib** kiyinmoq/yumoq/kelmoq/. . .

$$\mathrm{Pf}_{\mathrm{Adj,Adv}} = \begin{cases} \mathrm{Pf}^{\mathrm{Adj}}, & \text{if } \mathrm{Pf}^{\mathrm{Adj,Adv}} + \mathrm{aff}^{\mathrm{deg}} \oplus N^{\mathrm{PF}_{\mathrm{Adj}}} \\ \mathrm{Pf}^{\mathrm{Adv}}, & \text{if } \mathrm{Pf}^{\mathrm{Adj,Adv}} \oplus V \end{cases} \tag{4}$$

Using the model (4), it is possible to determine the polyfunctionality of the adjective ∨ adverb word group.

Determining the polyfunctionality between the conjunction ∨ auxiliary. The conjunction ∨ is modeled using the polyfunctionality event between the auxiliary and the word as follows (if it becomes a conjunction bilan):

Ota bilan bola/gul bilan lola/oq bilan qora/kelish bilan ketish/oy bilan quyosh/. . ..
Qunt bilan o'qi/aql bilan o'ylamoq/tuni bilan ishlamoq/. . ..

$$\mathrm{Pf}_{\mathrm{Conj,Aux}} = \begin{cases} \mathrm{Pf}^{\mathrm{Conj}}, & \text{if } W^{\mathrm{Conj}} \oplus \mathrm{Pf}^{\mathrm{Conj,Aux}} \oplus W^{\mathrm{Conj}} \\ \mathrm{Pf}^{\mathrm{Aux}}, & \text{if } W^{\mathrm{Aux}} \oplus \mathrm{Pf}^{\mathrm{Conj,Aux}} \oplus V \end{cases} \tag{5}$$

With the help of this mathematical model, it is possible to identify words that create polyfunctionality between the conjunction and auxiliary words. Similar mathematical models can be developed to identify other groups of polyfunctional words in the hierarchy of the above classification of polyfunctional words. To correctly define

polyfunctionality, it is necessary to distinguish the set of words that can be combined with these words. In short, a large amount of context is necessary. With enough context, models can be tested.

There are a number of models of information systems, for example, information model, conceptual model, models representing business processes in the system. In today's article, we describe the processes that determine polyfunctionality in the system. A number of notations can be used to model business processes. UML, IDEF3, BPM notations are among them. One of the modern notations in business process modeling is BPM notation. The following business processes are modeled using this notation. The information system for semantic analysis of sentences in the Uzbek language performs general processes as shown in Fig. 3, and each complex process includes several processes. Initially, the sentence entered by the user is divided into tokens. We make sentences in the Uzbek language using only blank spaces, because commas (,) in the sentence are also important in determining homonymous modal words.

The next process is the process of removing unnecessary words (StopWords), which involves removing words from the sentence that do not affect its semantics. Unimportant words in the Uzbek language are found among word groups such as conjunctions, prepositions, pronouns, adverbs. There are also such word combinations that, when encountered in the text, remain insignificant for its semantics, but these words are sometimes important in the composition of texts. Although the list of bigrams and trigrams of such ambiguous words was separately highlighted by Madatov and Bekchanov [6]. A total of 182 purely StopWords can be seen in the list of purely stopWords, that is, words that do not affect the semantics of any sentence. In this article, since the processes of semantic differentiation of polyfunctional words in the sentence are considered, we turn to the 4th process in the main Fig. 3. After removing ambiguous words from the sentence, the main process is to check whether a polyfunctional word is included in the sentence.

It is determined how many parts of speech meet the polyfunctional word found in the sentence in the business process presented in Fig. 4. It is known that polyfunctional words in the Uzbek language are found within two or three parts of speech. A separate rule is developed for each group of polyfunctional words presented in Fig. 2. Because polyfunctional words can be defined by their morphological features. In the Uzbek language, polyfunctional words within two part of speech are divided into 15 groups. Figure 6 shows the business process for defining polyfunctionality within two sets of words. Each process presented here is based on pre-developed grammatical rules. Similarly, the BPMN model of the business process, which semantically differentiates polyfunctionality within three parts of speech, is presented in Fig. 5. *The main goal of the article is to distinguish polyfunctional words, which are one of the elements of the semantic analyzer of the Uzbek language, based on the above-mentioned business processes. Based on the mentioned mathematical models and algorithms, we believe that we have approached the goal. Before developing an information system for semantic analysis of sentences in the Uzbek language, it is required to develop its architecture, structure, and conceptual models. This information system was developed based on the Django MVT (Module View Template) architecture.*

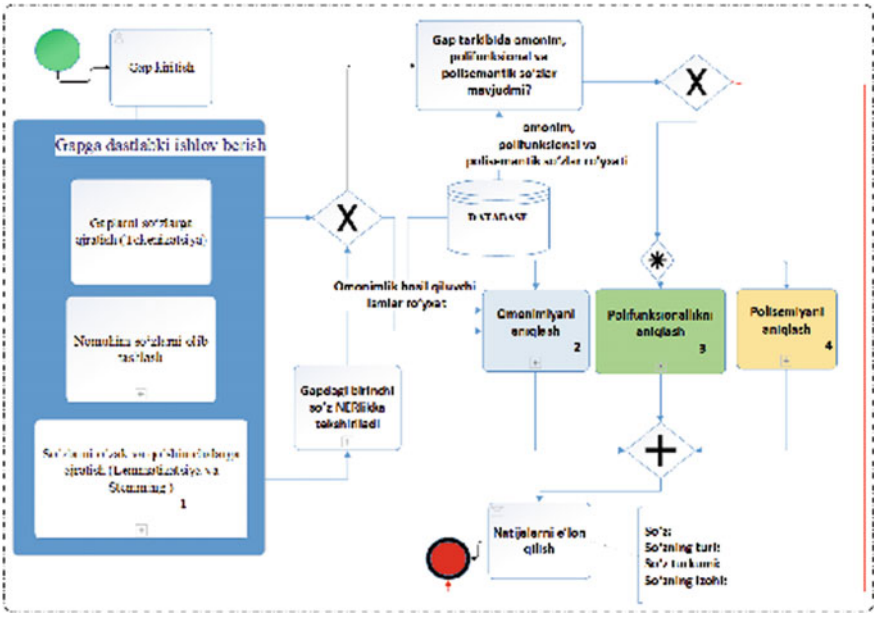

Fig. 3 BPM model of general information system processes

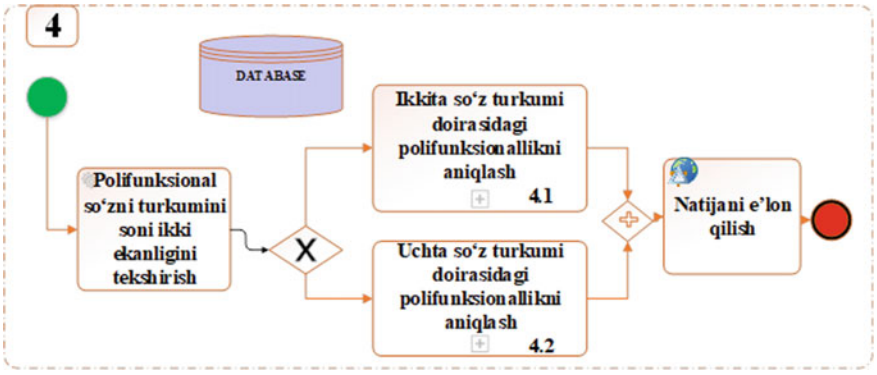

Fig. 4 Process of determining in which part of speech a polyfunctional word can be found

The capabilities of the Django framework were used in the development of the information system. The structure of the information system for semantic analysis of sentences in the Uzbek language has also been developed. Based on the architecture and structure of the information system that analyzes sentences in the Uzbek language, a conceptual model has also been developed. With the help of a conceptual model, the function of the information system can be understood at a glance. It follows from this that it is possible to see the processes that take place in the identification of polyfunctional words and the methods used in their implementation.

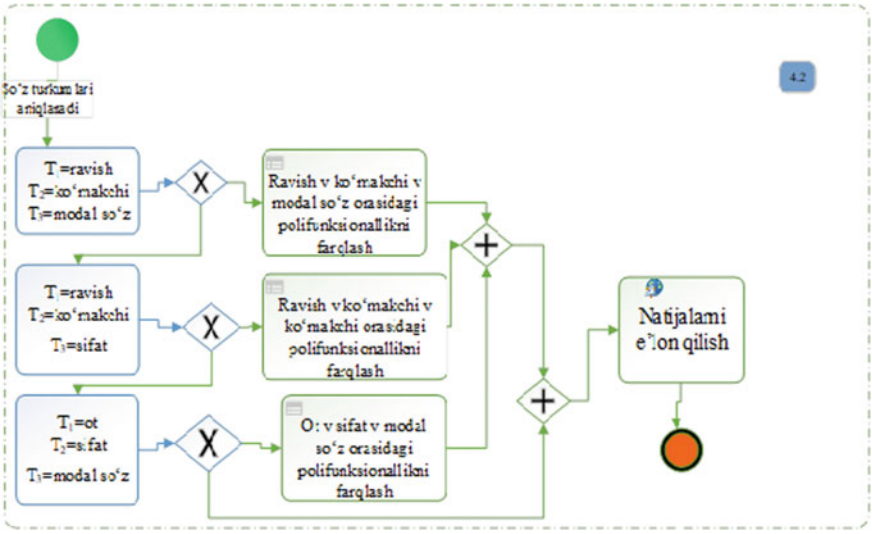

Fig. 5 Process of determining polyfunctionality within three parts of speech

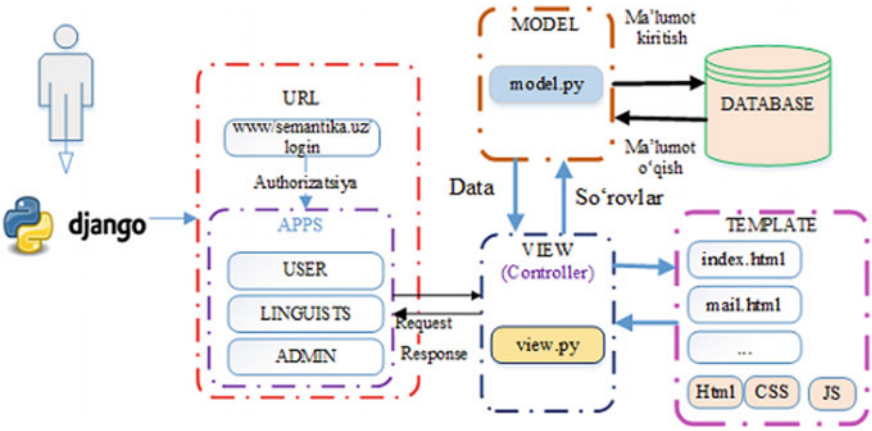

Fig. 6 Information system architecture

4 Conclusion

The role of polyfunctional words in the development of the information system for the semantic analysis of sentences in the Uzbek language is significant. Polyfunctional words in the Uzbek language can be determined using methods based on basic rules for semantic differentiation. Because they differ in morphological characteristics. In the development of the information system for the semantic analysis of polyfunctional words in the Uzbek language, a number of rules have been developed [7–9], and

each functional process in the information system has been defined and their BPMN models have been developed. In order to differentiate polyfunctional words in the Uzbek language in the context, connections between words are of course of great importance. 101 sentences were entered into the developed information system as a test. The number of exact results obtained from the entered sentences was 71. Overall 71.7% accuracy was achieved. It is advisable to use machine learning and artificial intelligence methods to further increase efficiency. These connections are called Grammatical connection in Turkic languages. Semantic analyzers are developed using the interaction of words in a sentence.

References

1. Vinogradova YN (2021) Vplotnuyu k narechnym predlogam (kvoprosu o polifunksionalnyx edinitsak). Russkiy yazyk za rubejom 1
2. Gorina II (2014) Leksema slovna polifunksionalnoye slova sovremennogo russkogo yazyke. Innobatsii i investitsii 4:178–180
3. Elov BB (2022) Text generation in Uzbek using *N*-gram language models, computational linguistics: problems, solutions and perspectives. In: Collection of international scientific and practical conference. Electronic publication, ebook, Tashkent
4. Xu X, Tokarchuk IN (2022) The main types of usage of a multifunctional word "literally" in modern Russian. Litera 25(8):236–249. https://doi.org/10.25136/2409-8698.2022.8.38594
5. Salvadori J, Huyghe R (2023) Affix polyfunctionality in French deverbal nominalizations. Morphology 33(1):1–39. https://doi.org/10.1007/s11525-022-09401-4
6. Khabibulla M, Shukurla B, Jernej V (2021) Lists of Uzbek stopwords (version 1) [data set]. Zenodo. https://doi.org/10.5281/zenodo.5659638
7. Boltayevich EB, Ilxomovna AX (2022) Business process modeling that distinguishes homonymy within three parts of speechs in the Uzbek language. In: Proceedings—7th international conference on computer science and engineering, UBMK 2022. Institute of Electrical and Electronics Engineers Inc, pp 278–283. https://doi.org/10.1109/UBMK55850.2022.9919453
8. Elov BB, Axmedova XI (2022) Uchta so'z turkumi doirasidagi omonimiyani farqlovchi biznes jarayonni modellashtirish. O'zbekiston respublikasi innovatsion rivojlanish vazirligining, Ilm-fan va m innovasion rivojlanish ilmiy jurnal 1:150–162
9. Axmedova XI (2022) Turli so'z turkumlari orasidagi omonimiyani aniqlovchi matematik modellar. Sci Innov Int Sci J 1(7):8.2. Issn: 2181-3337. https://doi.org/10.5281/zenodo.7238546
10. Pradhan S, Loper E, Dligach D, Palmer M (2007) SemEval-2007 task-17: english lexical sample, SRL and all words. In: Proceedings of the fourth international workshop on semantic evaluations (SemEval-2007), pp 87–92
11. Ide I, Véronis J (1998) Word sense disambiguation: the state of the art. Comput Linguist 24(1):1–41
12. Navigli R (2009) Word sense disambiguation: a survey. ACM Comput Surv (CSUR) 41(2):10
13. Tripathi P, Mukherjee P, Hendre M, Godse M, Chakraborty B (2021) Word sense disambiguation in hindi language using score based modified lesk algorithm. Int J Comput Digit Syst 10(1):939–954. https://doi.org/10.12785/IJCDS/100185
14. Zouaghi A, Merhbene L, Zrigui M (2012) Combination of information retrieval methods with LESK algorithm for Arabic word sense disambiguation. Artifi Intell Rev 38(4):257–269. https://doi.org/10.1007/s10462-011-9249-3
15. Basuki S, Kholimi AS, Minarno AE, Sumadi FDS, Effendy MRA (2019) Word sense disambiguation (WSD) for Indonesian homograph word meaning determination by LESK algorithm

application. In: Proceedings of 2019 international conference on information and communication technology and systems, ICTS 2019. Institute of Electrical and Electronics Engineers Inc., pp 8–15. https://doi.org/10.1109/ICTS.2019.8850957
16. Elov BB, Axmedova XI (2022) Determining homonymy using statistical methods. “Hisoblash modellari va texnologiyalari (HMT 2022)” O‘zbekiston-Malayziya ikkinchi xalqaro konferensiyasi materiallari. Toshkent, 16–17 sept 2022, p 106
17. Uri R, Correia RA, Berger-Tal O (2017) Using machine learning to disentangle homonyms in large text corpora. Conserv Biol. https://doi.org/10.1111/cobi.13044
18. Park JY, Shin HJ, Lee JS (2022) Word sense disambiguation using clustered sense labels. Appl Sci 12:1857. https://doi.org/10.3390/app12041857
19. Gulyamova S (2020) Polifunksionallik xususida. In: O’zbekistonda ilmiy-amaliz tadqiqotlar. Mavzusidagi online konferensiya, vol 19. Toshkent, 15 Aug 2020, pp 46–48
20. Syun X (2003) Polifunksionalnye slova v russkom yazyke kak problema russko-kitayskix slovarey: Dis. ... kand. filol. nauk: 10.02.20: Moskva, 196 s. RGB OD 61:04-10/225-9