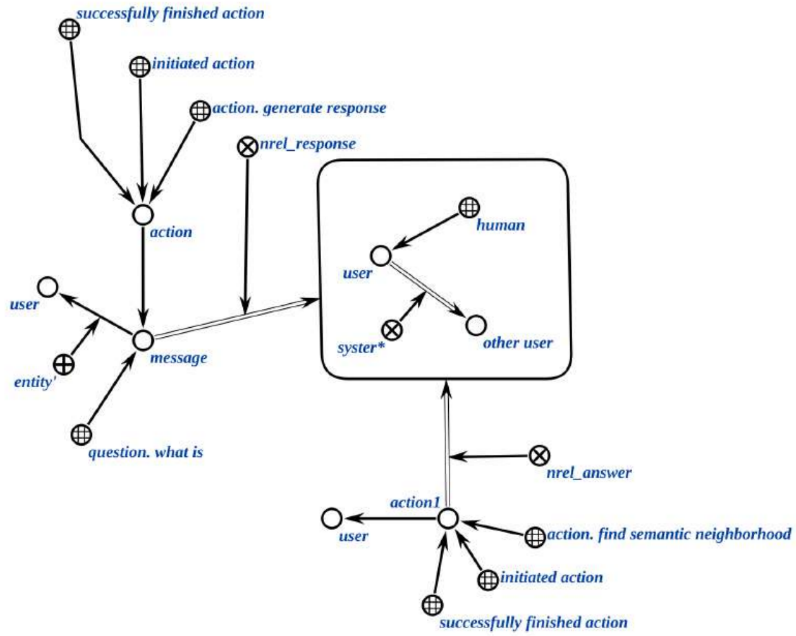

Рис. 1: An example of the output of the response generation agent.

algorithmic approach that builds a tree of dependencies between certain relations.

The actual generation of a natural language text is proposed as a two-step process, whereby a large language model generates the resulting text from an intermediate representation.

Due to the preliminary character of our work, there are certain limitations. Our approach does not discuss linearization of graph-based formal texts in greater detail apart from positing relatively straightforward schemata to be used during translation. In fact, given that the ultimate application of the module discussed here is natural language dialog between humans and intelligent systems, our proposed approach can be improved in three different ways:

- Firstly, understanding natural language questions to the system can be done using not a simple classifier but rather a combination of syntactic and semantic analysis modules that use a formalization of natural language syntax and semantics.
- Secondly, the linearization task can be solved in a much more elaborate manner. This would require formalization of a discourse structure model within the knowledge base of an ostis-system. The model can then be used to intelligently derive macro- and microstructures of sc-texts to be translated into a natural language.
- Finally, the actual translation of linearized sc-texts into a natural language needs further elaboration. An obvious improvement is to eliminate specific rules (mappings) of translating sc-constructions into certain predefined natural language verbalizations, which would require designing a proper natural language synthesis module.

  All of the above can be considered as potential directions for future research.

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References

[1] T. Yu, S. Zhang, and Y. Feng, "Truth-aware context selection: Mitigating the hallucinations of large language models being misled by untruthful contexts," 2024. [Online]. Available: https://api.semanticscholar.org/CorpusID:268364338

[2] Y. Wu, N. Hu, S. Bi, G. Qi, J. Ren, A. Xie, and W. Song, "Retrieve-rewrite-answer: A kg-to-text enhanced llms framework for knowledge graph question answering," 2023.

[3] V. Golenkov, Ed., Tehnologija kompleksnoj podderzhki zhiznennogo cikla semanticheski sovmestimyh intellektual'nyh komp'juternyh sistem novogo pokolenija [Technology of complex life cycle support of semantically compatible intelligent computer systems of new generation]. Bestprint, 2023.

[4] A. Goylo and S. Nikiforov, "Natural language interfaces of nextgeneration intelligent computer systems," Open semantic technologies for intelligent systems, no. 6, pp. 209–216, 2022.

[5] W. Mann and S. Thompson, "Rethorical structure theory: Toward a functional theory of text organization," Text, vol. 8, pp. 243–281, 01 1988.

[6] E. H. Hovy, "Automated discourse generation using discourse structure relations," Artificial Intelligence, vol. 63, no. 1, pp. 341–385, 1993. [Online]. Available: https://www.sciencedirect. com/science/article/pii/000437029390

[7] W. Kintsch and T. A. van Dijk, "Toward a model of text comprehension and production." Psychological Review, vol. 85, pp. 363–394, 1978. [Online]. Available: https://api. semanticscholar.org/CorpusID:1825457

[8] B. J. Grosz and C. L. Sidner, "Attention, intentions, and the structure of discourse," Computational Linguistics, vol. 12, no. 3, pp. 175–204, 1986. [Online]. Available: https://aclanthology.org/ J86-3001

[9] K. R. McKeown, "Discourse strategies for generating naturallanguage text," Artificial Intelligence, vol. 27, no. 1, pp. 1–41, 1985. [Online]. Available: https://www.sciencedirect.com/science/ article/pii/000437028590

[10] J. Liu, S. Cohen, and M. Lapata, "Text generation from discourse representation structures," 01 2021, pp. 397–415.

[11] C. Wang, R. van Noord, A. Bisazza, and J. Bos, "Evaluating text generation from discourse representation structures," in Proceedings of the 1st Workshop on Natural Language Generation, Evaluation, and Metrics (GEM 2021), A. Bosselut, E. Durmus, V. P. Gangal, S. Gehrmann, Y. Jernite, L. PerezBeltrachini, S. Shaikh, and W. Xu, Eds. Online: Association for Computational Linguistics, Aug. 2021, pp. 73–83. [Online]. Available: https://aclanthology.org/2021.gem-1.8

[12] C. Gardent, A. Shimorina, S. Narayan, and L. Perez-Beltrachini, "The WebNLG challenge: Generating text from RDF data," in Proceedings of the 10th International Conference on Natural Language Generation, J. M. Alonso, A. Bugarín, and E. Reiter, Eds. Santiago de Compostela, Spain: Association for Computational Linguistics, Sep. 2017, pp. 124–133. [Online].

[13] J. Guan, X. Mao, C. Fan, Z. Liu, W. Ding, and M. Huang, "Long text generation by modeling sentence-level and discourse-level coherence," in Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics and the 11th International Joint Conference on Natural Language Processing (Volume 1: Long Papers), C. Zong, F. Xia, W. Li, and R. Navigli, Eds. Online: Association for Computational Linguistics, Aug. 2021, pp. 6379–6393. [Online]. Available: https://aclanthology.org/2021.acl-long.499

[14] D. Shunkevich, "Hybrid problem solvers of intelligent computer systems of a new generation," Open semantic technologies for intelligent systems, no. 6, pp. 119–144, 2022.

[15] A. Goylo and S. Nikiforov, "Means of formal description of syntax and denotational semantics of various languages in nextgeneration intelligent computer systems," Open semantic technologies for intelligent systems, no. 6, pp. 99–118, 2022.

[16] L. Shu, L. Luo, J. Hoskere, Y. Zhu, Y. Liu, S. Tong, J. Chen, and L. Meng, "Rewritelm: An instruction-tuned large language model for text rewriting," 2023.

[17] M. Kovalev, A. Kroshchanka, and V. Golovko, "Convergence and integration of artificial neural networks with knowledge bases in next-generation intelligent computer systems," Open semantic technologies for intelligent systems, no. 6, pp. 173–186, 2022.

[18] V. V. Golenkov, N. A. Gulyakina, and D. V. Shunkevich, "Klyuchevye problemy i strategicheskie tseli rabot v oblasti iskusstvennogo intellekta [key problems and strategic goals of research in the field of artificial intelligence]," 2023, pp. 9–13.

[19] "ostis-metasystem repository," Available at: https://github.com/ ostis-ai/ostis-metasystem, (accessed 2024, March).

20] "Rasa," Available at: https://rasa.com/, (accessed 2024, March).

[21] "Wit AI," Available at: https://wit.ai/, (accessed 2024, March).

ГЕНЕРАЦИЯ ЕСТЕСТВЕННО-ЯЗЫКОВЫХ ТЕКСТОВ ИЗ БАЗ ЗНАНИЙ OSTIS-СИСТЕМ

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В статье описывается подход к генерации связных текстов на естественном языке из фрагментов баз знаний ostis-систем. Описана архитектура абстрактного sc-агента трансляции фрагмента базы знаний в естественный язык. Задача генерации естественно-языкового текста подразделяется на три подзадачи: фильтрация структуры, декомпозиция фрагмента базы знаний и генерация эквивалентного естественноязыкового текста. Предлагаются два способа линеаризации фрагментов базы знаний: использование заданной спецификации порядка элементов фрагмента и алгоритмический. Предлагается выполнять генерацию эквивалентного естественно-языкового текста в два этапа. На первом этапе формируется черновое естественно-языковое представление на основе правил сопоставления конструкций sc-текстов с соответствующими им естественно-языковыми формулировками. На втором этапе такое промежуточное представление транслируется в связный естественно-языковой текст с использованием большой языковой модели. Описываются три возможных применения предлагаемого подхода.

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Principles of Building Intelligent Robotic Systems

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***Abstract*—The paper proposes a concept for the building of collaborative robotic systems using OSTIS technology. The developed concept is based on the integration of robotic, symbolic and neural network components. The main provisions of the approach are illustrated by the project of a robotic system for sorting objects with specified characteristics. Recommendations are given on the application of the proposed concept for the construction of collaborative robotic systems in the context of the development of new generation intelligent computer systems based on the use of OSTIS technology.**

***Keywords*—OSTIS, collaborative robotics, hybrid intelligent systems, object detection, manipulators**

I. Introduction

In modern collaborative robotic systems, robots follow a set algorithm of actions, including the performance of some predefined operations (e. g., grasping and moving an object, positioning at a certain point, performing a certain operation on an object). Technically, the realization of such actions does not cause difficulties in case of an ideal workflow. However, there may be situations when there are deviations from the established algorithm of actions, for example, absence of an object in a given point by the beginning of the operation, wrong type of object or impossibility to perform the operation due to blocking of moving parts, appearance of unauthorized persons in the area of manipulator operation, etc. These problems can be solved by using machine learning methods, in particular, neural networks. For example, a detector network allows you to determine the type of object moving along the conveyor, another model calculates the position of the manipulator at the next moment of time depending on the technical operation being performed, etc. However, the use of only specialized auxiliary models, for example, a computer vision model for detecting missing objects, will not be able to help in the correct identification of the place where objects of a given type can be located and where, in case of absence of the object on the conveyor, it will be necessary to deploy the manipulator to grab the part. Information about important aspects of the manufacturing process, which is sufficiently variable, needs to be systematically stored because the alternative — the need for constant direct code editing in the context of changes occurring to the robot — is unacceptable and, moreover, can often lead to errors. In addition, the experience that such systems may acquire during their operation is also clearly important and needs to be properly represented for reuse in other contexts and processes.

Thus, the development of principles and recommendations for the construction of intelligent robotic systems is an urgent topic of research, because it allows to streamline the process of developing such systems. The use of modern tools for designing intelligent systems, which undoubtedly includes OSTIS technology, allows the representation and operation of knowledge, which is a valuable resource in robotic systems.

The subsequent sections of the paper are organized as follows: section II sets out the problem of building knowledge-based robotics systems, in the same section an overview of existing solutions is given; section III describes the proposed concept for building intelligent robotics systems; section IV describes the developed prototype of an intelligent robotics system for sorting objects of a given type; finally, section V summarizes the main conclusions of the proposed concept and describes the main conclusions of the intelligent robotics system for sorting objects of a given type.

II. Problem formulation

The idea of developing robotic systems based on the use of knowledge bases has been widely investigated in various works. For example, in [1], the authors give an overview of knowledge bases used in robotic systems to find missing tools. Emphasis is placed on finding those objects without which further workflow continuation will not be possible. However, other applications

of knowledge bases are not indicated, in particular, the possibility of using them for robot self-diagnosis, which is an important function of such systems. Other studies use knowledge bases (e. g., Cyc [2] or SUMO [3]) that are not specific to robotics, which makes it difficult to use such solutions in practice. One of the most promising solutions at the moment is the KnowRob KB ([4], [5]), which is characterized by a developed ontological basis for robotics.

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