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MODERN MATHEMATICAL LINGUISTICS

Mathematical linguistics is an interdisciplinary field of research at the intersection of mathematics and linguistics. She studies linguistic phenomena and structures using mathematical methods and models.

Mathematical linguistics is a branch of science that studies natural languages by applying mathematical methods and models. This discipline is at the intersection of linguistics, mathematics, computer science and statistics, and its development has become possible thanks to the synthesis of these scientific approaches. The main goal of mathematical linguistics is the formalization of language phenomena, the creation of models that can be used for analysis, understanding and generation of natural language.

Mathematical linguistics is the basis for many modern natural language processing (NLP) technologies, such as search engines, chatbots, automatic translation systems, etc.

The main directions of mathematical linguistics:

1. Formal grammars.

One of the key areas of mathematical linguistics is the study of formal grammars. Formal grammars are mathematical models that describe the syntactic structure of language statements. Among the most famous models are context-free grammars proposed by Noam Chomsky, which are widely used in computational linguistics and compiler theory.

Context-free grammar consists of a set of production rules [1], which determine how one part of the language can be replaced by another. These grammars are able to describe the structure of language, in particular such phenomena as nestedness and agreement.

2. Modeling of natural language.

Natural language modeling involves the creation of mathematical models that simulate the processes of human language comprehension and generation. These models can be both deterministic and stochastic, and they are used to solve various

natural language processing (NLP) tasks and subsequently create LLM [2, 3].

One of the important tasks is the creation of syntactic and semantic text analysis models that allow automating the processes of recognition, parsing and interpretation of linguistic data. For this, both classical machine learning algorithms [4-7] and modern approaches, in particular deep learning methods [8, 9], are used.

3. Theory of formal languages.

The theory of formal languages is another important component of mathematical linguistics. Formal languages are used to formalize the syntax of programming languages, as well as to model various aspects of natural languages. A formal language is defined through an alphabet and a set of rules that define the set of valid words (sequences of characters).

This theory also underlies automata and grammars, which are powerful tools for the study of linguistic structures, particularly in the tasks of constructing and parsing expressions in programming languages and natural languages.

4. Theory of information and coding.

The application of information theory in linguistics allows to analyze linguistic phenomena from the point of view of the amount of information transmitted and the efficiency of encoding linguistic messages. In this context, such issues as entropy of the speech signal, redundancy and compression of texts are investigated.

Information theory also plays an important role in the development of machine learning algorithms used for text classification, speech recognition, machine translation, and other natural language processing tasks.

5. Corpus linguistics and statistical methods.

Corpus linguistics deals with the collection, analysis and use of large arrays of text data (corpora) for the study of linguistic phenomena. The use of statistical methods in this field allows you to automate the processes of text analysis, to identify patterns, to determine the frequency of use of words and phrases, as well as to analyze the semantic connections between them.

Statistical models, such as models based on Markov chains, naive Bayesian classifier, latent semantic analysis methods, are used to create efficient text processing algorithms, including thematic modeling, text classification, and emotion recognition tasks.

Application of mathematical linguistics:

Mathematical linguistics has wide practical applications in various fields. The most important applications include:

– Machine translation: Creation of algorithms for automatic translation of texts from one language to another.

– Speech recognition: Development of systems capable of recognizing speech and converting it into text.

– Speech synthesis: Generation of artificial speech based on text.

– Search engines: Use of language processing algorithms to improve search results and text classification.

– Mood analysis: Determination of the emotional tonality of texts based on linguistic and statistical models.

Conclusions.

Mathematical linguistics is an important branch of science that combines theoretical aspects of linguistics with mathematical methods. It plays a key role in the development of natural language processing technologies and the creation of innovative solutions that allow automating and improving human-computer interaction processes based on language communication.

It is worth summarizing that currently mathematical linguistics and symbolic artificial intelligence (explicit knowledge bases) [10-14] are two classic and closely related fields that are based on the use of formal methods for modeling linguistic phenomena and creating intelligent systems capable of operating with symbols and perform logical operations. Both of these fields use precise mathematical methods to describe the structure of language and develop natural language processing algorithms. Symbolic AI uses structures and models of representation of explicit knowledge based on formal models of language developed in mathematical linguistics. Although symbolic methods have certain limitations, they continue to play an important role in tasks where precision and logical consistency are required, and find new applications in hybrid approaches together with statistical methods.

Discussion and prospects for further research.

The author reasonably emphasizes that Big Data [15-18] and machine linguistics are currently very interconnected fields, since modern technologies allow collecting and analyzing huge arrays of textual information for the study of linguistic phenomena and the creation of various application systems. The use of big data in linguistics provides new opportunities for deeper and more accurate analysis of language, expanding the boundaries of traditional methods. The application of Data Mining methods [19-21], statistical analysis and semantic evolutionary modeling [22-24] in combination with large arrays of text data contributes to the development of new natural language processing technologies that have wide practical application. At the same time, the effective use of big data in linguistics requires solving a number of technical and ethical issues that confront researchers and practitioners.

Considering the above, the author actualizes the adaptive use of Data Mining, Machine Learning and AI not only in the field of philological and/or pedagogical science, but also in the fields of education management at all levels [25, 26].

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