Advanced Semantic Networking

BASED ON THE LARGE LANGUAGE MODELS

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Causal networks
Bidirectional algorithm for causal network
    formation
Swarm of virtual experts
Scenario formation for activities
Hierarchy analysis using virtual experts
Network visualization
Direct speech extraction
Event analysis
Semantic indexing
Information retrieval and LLMs
Text reconstruction
News authenticity verification
Wikipedia biography verification
Narrative reconstruction
Semantic networks in cybersecurity
Semantic networks in the legal field
Ethical aspects of artificial intelligence
    application
Threats and challenges of Black Hat AI
Concept of creating White Hat AI
The era of no-code systems

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The modern era of information technologies requires innovative approaches to the analysis and use of textual data. Artificial intelligence, in particular large language models (LLM), provides unique opportunities for automating the creation and analysis of semantic networks. The book offers an interdisciplinary approach combining methods of generative artificial intelligence, mathematical formalization and practical application in the fields of social analytics, politics, information security and advertising. The book discusses new methods for creating, analyzing, and modifying semantic networks using LLM. Special attention is paid to the concept of a "swarm of virtual experts", which is based on the multiple selections of concepts and connections to form semantic structures, as well as the modification of these networks to obtain new texts or predictions. Approaches to solving such problems as the effective use of generative models for textual data analysis, the use of developed approaches in the field of cyber security, social monitoring, and political analysis are also proposed.

The monograph is intended for specialists in the field of artificial intelligence, researchers in the field of data analysis, information security and social analytics, as well as students of education who are interested in modern approaches to textual data processing. It will also be useful to practitioners working on forecasting, modeling and information impact tasks.

CONTENT

PREFACE

Artificial intelligence and its generative models, in particular large language models (LLM), have become an integral part of modern society, significantly changing approaches to data analysis, information retrieval and decision-making.

The revolutionary technology of the Transformer, as a neural network of a new level, changed the rules of the game in the field of artificial intelligence and, in general, all information technologies. It made it possible to create models and methods capable of efficiently processing large amounts of data, learning without a teacher and applying to a variety of tasks.

The focus of this book is semantic networking, a new technique that involves using LLM to create, analyze, and modify semantic networks.

The main goal of this book is to present new methods of forming and analyzing semantic networks, in particular, using the concept of a "swarm of virtual experts", which is based on repeated processing of requests (prompts) to LLM. This approach makes it possible to significantly improve the quality of answers when evaluating the parameters of semantic networks being formed, extracting information from texts, interpreting it and using it in applied tasks.

The book provides the methodological and technological principles of semantic networking, which include:

1. Development of a methodology for the formation of semantic networks using LLM, taking into account the frequency and significance of concepts and connections.

2. Use of modern tools for clustering and visualization of networks, in particular Gephi.

3. Creation of algorithms for modification of semantic networks that allow integration of new knowledge or reconstruction of texts.

4. Implementation of mathematical models for the formal description of the processes of construction and transformation of semantic networks.

5. Creation of new and improvement of existing decision-making support methods based on the application of LLM.

6. Practical testing of methods in many areas, including cyber security, legal sciences, and parliamentary control.

The book also demonstrates examples of practical application, in particular in the fields of cyber security, law, encyclopedism, and decision support.

The book is intended for researchers in the fields of artificial intelligence, information security, social analytics and data management. It also reveals the potential challenges and risks associated with the use of generative models, with an emphasis on the ethical aspects of their application.

By the way, this book contains almost no algorithms; instead, it features methodologies. There are no software codes or SQL queries; in their place, you will find prompts. The reason for this can be found in the section titled "The Era of Codeless Systems."

We hope that this book will inspire the reader for new research and implementation of innovative technologies for solving complex intellectual tasks in various fields of activity.

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Dmytro Lande

Leonard Strashnoy

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P.S. *This monograph largely consists of materials from preprints written by the authors over three years of the artificial intelligence revolution in various languages. Therefore, for the translation into English, we extensively used DeepSeek and ChatGPT services, which also provided additional structuring of the material, some of which we retained. Additionally, for the cover illustration, symbolizing the fusion of network technologies and artificial intelligence, we used the Bing Image Creator service.*

1 INTRODUCTION

In a world where information is one of the key resources, the methods of its analysis, generalization and use acquire special importance. Semantic networks, considered as a basis for knowledge modeling, allow visualizing the connections between concepts, creating a structured representation of information. On the other hand, large language models (LLM) have opened a new era in processing textual data, capable of structuring it, detecting entities, and generating and modifying high-quality texts.

This book brings together these two powerful classes of tools, namely linguistic models and network analysis tools, through the proposed semantic networking technology. This approach allows you to build, analyze and modify semantic networks based on text data processing using LLM. This approach opens up new horizons in the study of relationships between concepts, prediction of events, automation of text creation, and even modeling of informational influence. The purpose of this book is to present methods for creating, analyzing, and modifying semantic networks using LLM. Special attention is paid to the concept of a "swarm of virtual experts", which is based on multiple selections of concepts and connections to form semantic structures, as well as modification of these networks to obtain new texts or predictions.

However, this book not only describes the methodology, but also demonstrates how the combination of semantic networks and LLM can be applied in areas such as social analytics, information security, political forecasting, advertising, and science. This opens up opportunities for researchers and practitioners who seek not only to understand but also to actively change information flows based on modern technologies.

Semantic networks and large language models are not just tools, but powerful technologies that open up new opportunities for analysis, modeling and information management. Therefore, this book offers readers not only theoretical knowledge but also practical instructions that will help to apply these technologies in their work and research.

This Introduction section reviews the fundamental aspects of semantic networks and large language models, laying the groundwork for understanding the proposed approach. In the first paragraph of the introduction, attention is paid to the history, development and principles of operation of semantic networks. In the second part, the possibilities of LLM, their evolution, and their use in text analysis are uncovered. This knowledge will become essential for deeper engagement with the primary subject of study − semantic networking technology. The formation of semantic networks involves the identification of key concepts and the establishment of

connections between them. This process can be manual or automated, depending on the volume and complexity of the data. Semantic network analysis involves identifying key concepts, determining their importance, and exploring the relationships between them. This approach allows you to get a deep understanding of textual data and reveal hidden patterns.

The second section "Semantic networking: formation of semantic networks" contains information that the integration of means of analysis of textual information and visualization allows to automate the process of formation of semantic networks. LLMs are used to extract key concepts and establish relationships between them, while visualization tools, particularly the Gephi program, provide representation and analysis of the resulting networks. The virtual expert swarm concept is based on multiple text analysis using LLM. Each "expert" highlights his key concepts and connections, which allows the creation of multidimensional semantic networks. Hierarchical formation of cause-and-effect networks allows the modeling of complex relationships between events and their consequences. This approach is used to predict events and analyze their impact.

In the third section, the issue of information extraction and semantic indexing of text documents is considered. Among other tasks, automatic extraction of direct speech allows you to highlight key statements and quotes from textual data, which simplifies the analysis and interpretation of information. The formation of networks of concepts in the legal field helps in understanding complex legal concepts and the relationships between them. This simplifies the analysis of legal documents and decision-making. Analysis of events based on generative artificial intelligence allows predicting future events and analyzing their impact on various areas of life. Semantic indexing of documents allows you to create structured knowledge bases, which simplifies the search and analysis of information in various fields. Network visualization helps in visualizing complex relationships between concepts, which facilitates navigation and analysis of information. The issue of combining information retrieval technologies and artificial intelligence is also discussed in Chapter 5. This integration allows for the detection and analysis of cyber threats, which contributes to more effective information protection. Using LLM to improve search accuracy allows you to find more relevant results and simplifies the process of finding information

The fourth chapter is devoted to the reverse construction of semantic networks of the process, namely the reconstruction of texts on the basis of already formed semantic networks. Reconstruction of texts through semantic networks and LLM allows to restoration of lost information and the generation of new texts based on existing data. On this basis, a methodology for checking the reliability of data (for example, from Wikipedia) is also

proposed. The data reliability testing methodology helps in determining the accuracy and reliability of the information used to reconstruct the texts.

Semantic indexing of arrays of information allows you to create structured knowledge bases, which simplifies the search and analysis of large volumes of data.

Chapter 5 deals with the application of semantic networking in various fields of activity. Semantic networks help in modeling and analyzing various types of cyber threats, which contributes to the development of more effective protection measures. Visualization and analysis of data, in particular, of cyber threats with the help of AI allows you to visually represent the complex relationships between cyber threats and identify their causes and consequences. The formation of networks of vulnerabilities and cyber security actors helps in the detection and analysis of vulnerabilities, which contributes to the improvement of information protection. Applied problems and the application of semantic networking in parliamentary control are also considered, in particular, the analysis of event networks in the field of parliamentary control is considered. This allows modeling and analysis of various events taking place in the parliament and their impact on the political situation.

The sixth chapter is devoted to issues of technology integration and decision support. Decision support based on a large number of criteria allows taking into account various factors, which contributes to more effective decision-making. Dynamic network formation through generative artificial intelligence enables automatic adaptation to changes in data and context, enabling more efficient analysis and modeling. The formation of activity scenarios allows you to model various options for the development of events and analyze their impact on various spheres of life.

The seventh chapter is devoted to ethical issues in the application of artificial intelligence and covers an examination of the challenges of Black Hat AI and its practical aspects. Threats of Black Hat AI implementation force to model and analyze various scenarios form the concept of creating White Hat AI, which contributes to more effective protection against cyber threats.

Chapter eight provides conclusions and perspectives relevant to the main content, allowing readers to gain an overview of the main ideas and concepts presented in the book. Prospects for the development of the methodologies presented in the book and possible directions for further research are also discussed.

The book offers approaches to solving such problems as the effective use of generative models for analyzing textual data, modifying texts and creating new materials, integrating ethical aspects into the processes, practical

application of the developed approaches in the field of cyber security, social monitoring, and parliamentary control.

As such, this book will be a useful resource for researchers and practitioners interested in innovative approaches to semantic networks and the use of LLM in various fields. It offers an interdisciplinary approach combining methods of generative artificial intelligence, mathematical formalization and practical application in the fields of social analytics, politics, information security and advertising. The publication is intended for specialists in the field of artificial intelligence, researchers in the field of data analysis, information security and social analytics, as well as students and teachers who are interested in modern approaches to text data processing. It will also be useful to practitioners working on forecasting, modeling and information impact tasks.

Next, we will consider the main theoretical and practical principles, which are the foundation for further consideration of semantic networking, the main topic of this book.

1.1 Semantic networks

Semantic networks are a universal tool for modeling and organizing knowledge in the form of graphs, where vertices represent concepts, and connections between them reflect semantic relations. Such graph structures make it possible to create multidimensional fields of knowledge that are easily adapted to solve various tasks in many fields. They make it possible not only to visualize the connections between elements but also to analyze more deeply their content and interaction.

The first steps in the use of semantic networks were made as early as 1956 when Richard Richens was developing approaches to machine translation at the Cambridge Center for the Study of Languages. In this early concept, semantic networks served as an intermediate graph model that facilitated the translation of texts between different languages by displaying meanings and semantic relationships. Since then, this idea has evolved significantly, forming the basis of many modern technologies focused on processing and presenting knowledge.

The concept of semantic networks gained special importance in the 1980s with the development of web technologies. It became the basis for the idea of the Semantic Web, the goal of which was to create a structured environment for a deeper understanding of information available online. Tim Berners-Lee, the inventor of the World Wide Web, proposed a vision of a web that would be understandable not only to humans but also to machines. Thanks to this, the web could automatically integrate data from different sources, find the information you need, and create intelligent applications.