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Research and Application of Multi-level Diverse Intelligent Algorithm Library Based on Artificial Intelligence Computing Platform

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Abstract. At present, artificial intelligence computing platforms are usually based on cloud hosts for services, which have the characteristics of fast training speed and a wide variety of model types. However, the online models of such platforms mostly adopt the form of downloading model files, which is difficult to integrate into traditional software system systems. In response to existing problems, this paper takes the relevant theoretical technologies of next-generation intelligent computing platforms as the development framework, and conducts research on the diversity of multi-level intelligent computing requirements, by implementing a universal algorithm model construction and automatic integration mechanism; Build a multi domain and multi-level application algorithm library for different application scenarios; Design a personalized algorithm recommendation based on knowledge reasoning and object-oriented approach, and build an emerging intelligent computing platform for analyzing and understanding real-world data, meeting the needs of complex engineering application software such as heavy backend, light frontend, loose coupling, microservices, etc., providing theoretical and technical support for innovative big data services and applications with diverse computing requirements.

Keywords: Artificial intelligence, Computing platform, Automatic integration, Multi-level, Algorithm recommendation.

1. Introduction

With the rapid development of fields such as the Internet of Things and big data, data is gradually integrating into various industries of social development, receiving high attention from governments at all levels, experts in the field, and business people, and has become a research hotspot in the current academic and industrial circles. Effectively performing intelligent computing on massive and complex data, discovering hidden knowledge and patterns in the data, and then mining potential value in the data will greatly promote the development of various fields in society. The rapid growth of data has brought valuable value to many industries, while also posing significant challenges for efficient computation of massive amounts of data. Therefore, developing high-performance intelligent algorithm platforms to meet the current demand for intelligent analysis and knowledge mining of massive data is becoming an emerging research hotspot [1-3].

The artificial intelligence computing platform is based on high-performance computing architecture, data resource management, and deep learning intelligent algorithm library. It is a public basic computing research field that deeply integrates computer science, data science, and network science. Artificial intelligence computing platforms, as the foundation of next-generation intelligent computing, have attracted widespread attention due to their diversity of algorithms and other characteristics [4,5]. The artificial intelligence computing platform utilizes intelligent algorithms to recommend solutions, mine the intrinsic value of data, depict the development trend of scientific research, and reveal the laws of social evolution and development. It is of great significance to promote social progress, improve people's quality of life, and maintain sustainable social development [6-8].

As the foundation of data intelligent computing, intelligent computing platforms provide computational support for various scientific research, efficiently mine the inherent laws contained in data, and provide solutions for many problems such as accurate business decisions [9,10]. In order to effectively design a reasonable intelligent computing paradigm, it is necessary to conduct in-depth and comprehensive design of artificial intelligence computing platforms. However, the development and reconstruction of artificial intelligence computing platforms is not an easy task, and its challenges mainly stem from the diversity of computing requirements. Therefore, this paper takes the theoretical technology related to next-generation intelligent computing platforms as the development framework, and conducts research on the diversity of multi-level intelligent computing requirements. Using intelligent recommendation algorithm libraries as a means [11,12], develop a high universality and diversity intelligent algorithm library platform to meet the needs of complex engineering application software, such as heavy backend, light frontend, loose coupling, microservices, etc., and build an emerging intelligent computing platform for analyzing and understanding real-world data.

2. Research Status

The research on intelligent algorithm libraries mostly relies on algorithm platforms for implementation. Algorithm platform is a platform concept that has emerged recently. It refers to encapsulating the implementation of algorithms, providing relevant algorithm APIs for platform users to use, and providing a computing platform for algorithm training. Currently, mainstream algorithm platforms can be mainly divided into two categories: research-oriented algorithm platforms and engineered algorithm platforms. The research-oriented algorithm platform is designed to study models with higher accuracy and faster training methods, rather than starting from the usability of the algorithm platform. The purpose of the engineering algorithm platform is to enable ordinary developers to implement models and achieve full automation of the model training process [13-15]. These platforms generally have a thorough encapsulation of algorithms, providing one-stop algorithm services for platform users, eliminating the need for algorithm code writing, deployment, operation, and maintenance. At the same time, the domestic and foreign industrial sectors have also launched some general engineering algorithm platforms, which are generally based on cloud hosts for services and have the characteristics of fast training speed and a wide variety of model types. However, in order to achieve better universality, these platforms use the form of downloading model files to achieve online training of the trained models, which is difficult to integrate into traditional software systems [16-18].

The core content of the algorithm platform is still the construction and application of algorithm libraries. There are existing ITK and VTK image processing algorithm libraries, digital signal processing algorithm libraries, data structure algorithm libraries, and so on. With the development of artificial intelligence technology, many industries are increasingly adopting AI technology to solve the problems they face in their own fields and have achieved many results. Mastering certain artificial intelligence technologies, combining traditional industries with artificial intelligence, integrating existing scientific problems with artificial intelligence theories, and using artificial intelligence technology to solve various problems in social life, production, and research has become an effective means of promoting development. The existing artificial intelligence algorithm libraries include MLlib, Mahout [19,20], etc., which provide distributed parallel implementations of some scalable classic algorithms in the field of machine learning, such as clustering, classification, recommendation filtering, and frequent sub item mining. However, due to the complexity of artificial intelligence technology itself, the continuous expansion of application fields, and the continuous derivation of practical problems, how to efficiently and conveniently enable personnel at all levels in various fields to apply relevant technologies has become an urgent problem to be solved [21-23].

With the continuous increase in people's demand for intelligence, it is worth noting how to easily and quickly find specific research methods due to the rich forms and complex types of algorithms. The existing traditional recommendation algorithm collaborative filtering has achieved great success in current research and application. However, when the user's historical data is sparse, the performance of the model will be limited. In recent years, the application of knowledge graphs in fields such as information filtering [24] and semantic analysis [25] has achieved great success in the academic community. The knowledge graph contains entity information from different domains and relationship information between entities, which can effectively alleviate the problem of data sparsity in collaborative filtering. Therefore, the introduction of knowledge graph based hybrid recommendation models has gradually attracted great attention from researchers. Reference [26] proposed the application of hierarchical category information from DBpedia knowledge graph to recommendation tasks, and they searched for recommended entities in the knowledge graph through propagation activation algorithm. Reference [27] established a music recommendation model by calculating the semantic distance contained in the knowledge graph.

Although some scholars have proposed models and methods for developing computing platforms, there are still some shortcomings and many key issues that need to be addressed urgently. In terms of algorithm library construction, how to build intelligent algorithm libraries that are suitable for various fields and populations, and can be quickly integrated and expanded; How to form a multi domain and multi-level application algorithm library with stronger usability, better interactivity, and the ability to be used for teaching applications in the field of algorithm library layering; How to solve the problem of massive artificial intelligence algorithms being irregular, unstructured, and having complex retrieval in the algorithm library recommendation [28,29]; How to implement object-oriented personalized algorithm intelligent recommendation, meet diversity needs, and solve the problems of users facing difficulties in selecting a large number of algorithms, long time consumption, and purposelessness.

In response to existing issues, this paper designs a multi-level intelligent algorithm library that caters to diverse needs. Research on the online adjustment mechanism of virtual resources for dynamic application perception, and develop effective resource management methods; Propose a universal algorithm model and unify algorithm standards; Propose algorithm automatic modeling technology to transform algorithms into standardized forms; Propose an automatic algorithm integration mechanism to automatically integrate algorithms that meet the standards into the algorithm library, achieving intelligent expansion of the algorithm library; Propose a pattern of domain differentiation [30], user structuring, and problem concretization to form a multi domain and multi-level applica-

tion algorithm library with stronger usability, better interactivity, and teaching applications; Propose personalized algorithm recommendation and intelligent question answering technology based on knowledge reasoning to meet the needs of diverse algorithms. Intended to promote the application of artificial intelligence algorithms in various industries and bring great convenience to users.

3. Research Content

This paper will investigate the construction of intelligent algorithm libraries suitable for various fields and populations, the hierarchical classification of high availability algorithm libraries by domain, and algorithm recommendation strategies for knowledge reasoning to meet diverse algorithm needs.

3.1. Dynamic Computing Resource Scheduling Strategy Based on Computational Perception

This paper studies the online adjustment mechanism of virtual resources for dynamic application perception, and forms an effective resource management method. The problem can be defined as: Given a batch of virtual machines and their resource requests, at any stage, allocating the required bandwidth and placing it in a reasonable location with the goal of minimizing costs [31-33]. The cost mainly consists of two aspects. On the one hand, it is the network communication cost, defined as the network traffic that needs to be carried within a specific stage and given resource allocation. On the other hand, it is the cost of adjusting and the cost of virtual machine migration required for resource adjustment. In addition, solving this problem requires certain constraints to be met. The network resources allocated to the virtual machine should not exceed the remaining bandwidth of the physical server, and the size of the virtual machine should not exceed the remaining capacity of the physical machine. In summary, the problem can be formally described as:

$$\min \sum_{q=0}^{m} g(P^q) + \beta \sum_{q=0}^{m} Impl(P^{q-1}, P^q). \tag{1}$$

$$s.t. \sum_{i}^{|V|} \sum_{j}^{|V|} b_{ij}^q \cdot p_{ix} \leq B_x, \forall q, \forall x. \tag{2}$$

$$\sum_{i}^{|V|} s(v_i) \cdot p_{ix}^q \leq s(h_x), \forall q, \forall x. \tag{3}$$

The server set is $|H|$, h_x represents the $x-th$ server, and the virtual machine set is $|v|$, v_i represents the $i-th$ virtual machine,represents whether the virtual machine is placed on the server, and the value is 1 or 0. $s(v_i)$ and $s(h_x)$ respectively represent the size of the virtual machine and the remaining resources of the server. The final bandwidth allocated between virtual machines is b_{ij}^q,and q is the stage number.The communication cost is defined as:

$$g(P^q) = \sum_{i}^{|V|} \sum_{j}^{|V|} \sum_{x}^{|H|} \sum_{y}^{|H|} b_{ij}^q p_{ix} p_{jy}. \tag{4}$$

The adjustment cost refers to the migration cost required to adjust the allocation strategy P^{q-1} from the previous stage to the current stage's strategy,represented by $\beta Impl(P^{q-1}, P^q)$, where β represents the cost required to migrate virtual machines of unit size, and $Impl(P^{q-1}, P^q)$ is defined as:

$$Impl(P^{q-1}, P^q) = \sum_{i}^{|V|} \sum_{x}^{|H|} s(v_i)(p_{ix}^{q-1} \wedge p_{ix}^q). \tag{5}$$

After providing the strict formal definition mentioned above, the resource adjustment problem of optimizing application perception is defined as the problem of comprehensively optimizing the communication cost and adjustment cost during the execution process of the application. Solving the optimization problem yields the solution to the resource adjustment problem.

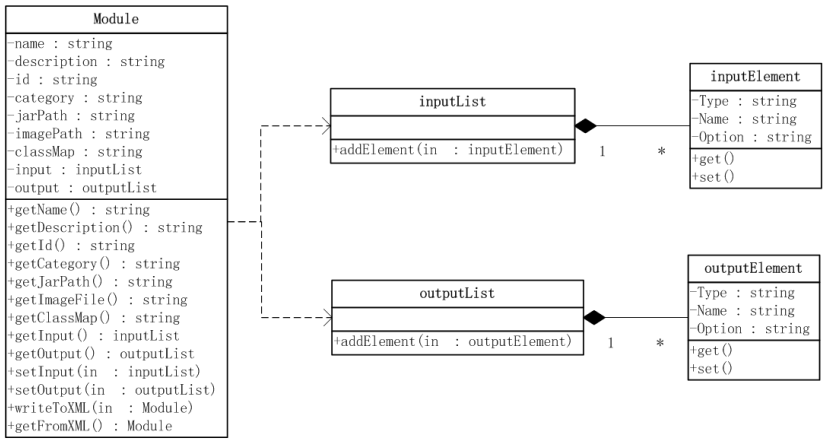

Fig. 1. Algorithm model class diagram

3.2. General Algorithm Model Construction and Automatic Integration

By analyzing the algorithm models in the current field and combining the relevant characteristics and application research features of various algorithms [34,35], an unified and universal algorithm model that conforms to the algorithm features in the current intelligent algorithm library is proposed as shown in figure 1.

The model includes the following parts: 1. Algorithm name, 2. Algorithm description, 3. Algorithm display icon, 4. Algorithm category, 5. Algorithm execution parameters, 6. Jar package path for algorithm execution and parameter configuration, 7. Path of algorithm execution method in the jar package (similar to org. Apache. hadop...), etc.

Research the automatic conversion technology from ordinary algorithms to algorithms that meet the model standards for the established unified algorithm model. Implement the automatic conversion of the original algorithm uploaded by the user into an algorithm that meets the standards of the model according to the various parts of the algorithm model. The modeled algorithm is called an algorithm component. The research on automatic modeling technology of algorithms and the application of established algorithm models in practice is a key step in automatic algorithm integration.

Based on the research of the general algorithm model mentioned above, an algorithm component should include: original algorithm jar package, algorithm icon, algorithm description file, and parameter configuration related classes as shown in figure 2. Among them, the original algorithm and algorithm icon are uploaded by the user, and the algorithm description file and parameter configuration related classes are automatically generated after uploading. The algorithm description file is a text file in XML format, and the parameter configuration related classes and the original algorithm are both. jar files.

The modeled algorithm has already met a unified standard, and based on this, we will study automatic integration technology. Automatic integration refers to the automatic recognition of a modeled algorithm component after uploading it, and the automatic loading of the component into the resource library; Meanwhile, the call execution method of the integrated algorithm component is the same as that of the original algorithm component. The automatic integration of modeling algorithms includes two parts of research content: the integration of front-end algorithm component display module and the integration of back-end algorithm capability execution module. The algorithm library provides a display module for algorithm components and a backend execution module. Users can view the description function and other information of the algorithm in the display module. The backend execution module actually calls the algorithm for analysis and processing. Therefore, after the automatic integration of the modeled algorithm, it should also be able to be viewed in the display module and called when the backend application is executed.

3.3. Multi-domain and Multi-level Application Algorithm Library

While focusing on fundamental theoretical research and innovation, the paper actively conducts interdisciplinary research with other disciplines, striving to promote the deep integration of industry, academia, and research, and provide technological support for the high-quality development of the industry. Therefore, the team has sufficient research foundation to build algorithm libraries in various fields, such as traditional Chinese medicine diagnosis and treatment systems, industrial process intelligence systems, fault analysis systems, etc [36-38].

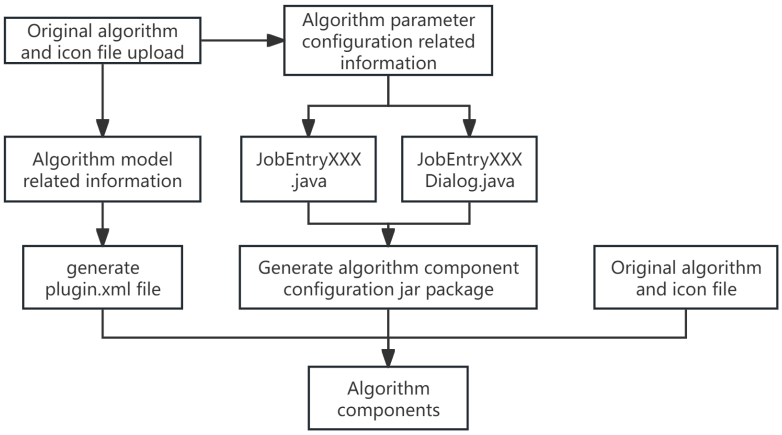

Fig. 2. Algorithm automatic modeling process

The intelligent algorithm library, as a tool for solving practical application problems, can also serve as an auxiliary teaching tool. The existing algorithm libraries rarely consider the differences in users' understanding and mastery of algorithms, and simply stack all algorithms, which is not convenient for users to choose according to their own situation. This intelligent algorithm library classifies algorithms based on their complexity, and constructs basic algorithm libraries, specialized algorithm libraries, and domain algorithm libraries respectively. Students can also deepen their understanding of algorithms by conducting simple experiments through the algorithm library as shown in figure 3.

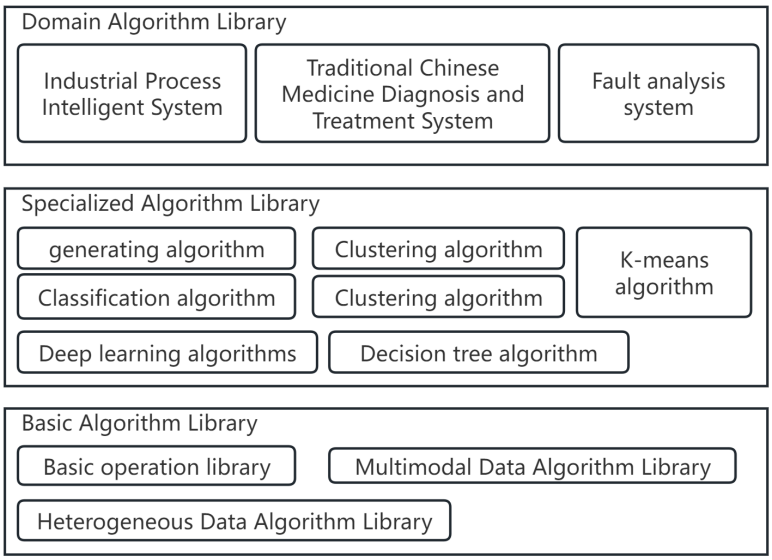

Fig. 3. Multi-domain and Multi-level algorithm library

At the same time, this intelligent algorithm library aims to provide users with algorithms that can solve problems conveniently and quickly. Establishing algorithm libraries for different data problems facilitates targeted use of relevant algorithms by users, saving filtering time. Our team has been conducting algorithm research in the field of big data for many years, including big data availability algorithms, multimodal data fusion algorithms, big data segmentation and indexing mechanisms, tensor based deep computing models for big data, algorithms that support cloud data privacy protection and encrypted computing, cross media computing algorithms, academic social network analysis, spatiotemporal trajectory data mining, etc. I have a comprehensive understanding of algorithms

for solving different data problems and have a good theoretical research foundation to build specialized algorithm libraries for different data problems.

3.4. Object Oriented Personalized Algorithm Recommendation

This intelligent algorithm library applies knowledge graph technology to construct an algorithm knowledge base, continuously expanding the graph by extracting knowledge between different algorithms as entities; Analyze the connections between different fields and data problems, store them in the algorithm knowledge base, and make the logic between algorithms in the library rich and easy to find.

The knowledge base stores the information generated by users in every process and step of using the algorithm library as knowledge. At the same time, when the user completes this use, the algorithms applied and the knowledge information queried will also be archived as graph data and graph relationship data. Thus continuously improving the accuracy of knowledge organization and push in the knowledge base, providing users with a more convenient and efficient knowledge push base, and conducting personalized algorithm recommendations based on knowledge graphs. Most recommendation models based on knowledge graphs are based on existing models, adding structured knowledge of entities such as users and algorithms in the graph to the recommendation model, and compensating for the data sparsity problem that existed in the early stages of the recommendation model by introducing additional knowledge [39,40].

The intelligent question answering system based on knowledge graph has two main steps: question semantic parsing (including entity recognition, mapping of question intention and relationship) and knowledge base answer retrieval. A knowledge base needs to construct entities, relationships, and attributes of a knowledge graph. Firstly, annotated corpora are generated through a data cold start mechanism. Then, based on a grid Bi LSTM CRF algorithm for entity recognition (including single entity recognition and multi entity recognition scenarios) and a word encoding CNN model for relationship/attribute mapping (including single relationship and complex relationship scenarios), the semantic parsing task of the problem is completed. Finally, a knowledge graph intelligent question answering system is implemented by converting query logic into query statements and retrieving answers from the knowledge base.

4. Conclusion

This paper is based on the latest developments in big data intelligent computing in terms of topic selection, focusing on solving the extremely important key technical problems in the emerging research field of next-generation intelligent computing platforms. With big data intelligent computing as the unified architecture, it provides new ideas for related research such as algorithm dynamic intelligent recommendation, and provides a solid foundation for intelligent computing in multiple fields such as computer science, network science, data science, and social science. It has obvious interdisciplinary nature and can provide reference for solving related problems in other fields. This paper innovatively studies the next generation of intelligent computing platforms from the perspective of intelligent computing algorithm libraries, which will assist the Weifang Key Laboratory of Artificial Intelligence Pattern Recognition in the research of deep learning and artificial intelligence algorithm theory, promote the interdisciplinary development of the laboratory, and cultivate world-class scientific research talents.

5. Conflict of Interest

The authors declare that there are no conflict of interests, we do not have any possible conflicts of interest.

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