
Scalable Computing: Practice and Experience, ISSN 1895-1767, http://www.scpe.org
© 2024 SCPE. Volume 25, Issues 5, pp. 3251–3258, DOI 10.12694/scpe.v25i5.3057

APPLICATION OF ARTIFICIAL INTELLIGENCE TECHNOLOGY AND DEEP LEARNING IN LABORATORY INTELLIGENT MANAGEMENT PLATFORM

XING LU*

Abstract. In order to effectively utilize data for laboratory management, a laboratory management model was studied, the author proposed a data-driven intelligent laboratory management process and logical architecture. For actual management work, there are mainly two types of operations: "Selection" and "action", the author proposes a data-driven laboratory intelligent management process and logical architecture; Based on the idea of big data, label systems are used to classify and store laboratory related data and laboratory evaluation GBDT and other algorithmic models; Building an intelligent laboratory management platform based on the label system has realized laboratory management functions, which are widely used and highly scalable. This data-driven laboratory intelligent management platform plays a role in the entire life cycle of laboratories, including laboratory demonstration construction, construction process management, experimental teaching and open use, operation management and maintenance, and experimental effect evaluation, and can promote the maximum effectiveness of laboratories, provide strong support for later construction project approval.

Key words: Artificial intelligence technology, Intelligent laboratory management, Application, Laboratory Evaluation GBDT Algorithm

1. Introduction. The term "artificial intelligence" was coined by McCartney, Minsky, Rochester and Shenon First proposed by a group of young scientists, it marks the emerging science of "artificial intelligence" Generation of family. Artificial intelligence has many advantages, including the following points: First, artificial intelligence can greatly save human cost. Second, artificial intelligence can greatly improve resource utilization. Third, AI can greatly improve work efficiency. Fourth, artificial intelligence has high commercial value. Fifth, artificial intelligence can free people's hands to focus on a better life. Sixth, artificial intelligence can promote social development and human progress. With the development of global economic integration, information technology has made great progress, Artificial intelligence technology has been widely used, such as car autonomous driving, robots Automatic sweeping, robot automatic cooking, robot waiter, rescue and disaster relief robot, Underwater robots and dance performance robots.

With the development of science, technology, and information technology, artificial intelligence theory has attracted more and more attention in recent years, not only because artificial intelligence technology can improve the efficiency of production and work, but also because of the emergence and application of artificial intelligence technology, it has greatly liberated human hands and is an important symbol of humanity's progress towards a new stage. It is conducive to understanding artificial intelligence technology [1]. Studying the theory of artificial intelligence, especially the transformation results of representative artificial intelligence technologies, is conducive to the widespread application of artificial intelligence technology, thereby reducing production costs, improving work efficiency, and benefiting the economic development of enterprises, contribute to China's economic and social development. It is conducive to the development of relevant industries and disciplines. Studying representative AI technologies is not only conducive to guiding the development of AI technology in the industry, but also conducive to the integration of other disciplines with AI, achieving the effect of one plus one greater than two, and promoting the development of relevant industries and disciplines. Third, it is conducive to stimulating the enthusiasm of the whole society for innovation. Through the popularization of artificial intelligence technology, people can realize that artificial intelligence technology is a discipline closely related to our daily life, through the transformation of theoretical achievements in artificial intelligence, it is possible to cultivate the enthusiasm of the whole society for creation and invention, thereby increasing the

*State-owned Assets Management Office, Jilin Agricultural University, Changchun, Jilin, 130118, China (XingLu167@163.com)

vitality of the development of artificial intelligence technology [2]. With the deepening of educational reform and the increasing demand for innovative, skilled, and talented people in society, investment in the construction scale, equipment, and practical teaching arrangements of university laboratories continues to increase, it has played an important role in cultivating socially applicable talents in colleges and universities. While meeting the needs of teaching practice, university laboratories also undertake heavy scientific research tasks, so the traditional manual management model is well suited to the new management requirements. Factors such as the increase in laboratory operation time and instrument usage frequency, as well as insufficient management personnel, not only reduce management efficiency, but also bring various safety hazards. Establishing innovative, open, and resource sharing central laboratories and adopting artificial intelligence technology for scientific management have become an inevitable trend in the development of university laboratories [3,4]. What is the significance of studying artificial intelligence: First, it is conducive to understanding artificial intelligence technology. Research artificial intelligence theory In particular, the main research on the transformation of representative artificial intelligence technologies, It is conducive to the wide application of artificial intelligence technology, thus reducing production costs and improving production Work efficiency, is conducive to the economic development of enterprises, for China's economic and social development Make a contribution. Second, it is conducive to the development of related industries and disciplines. Research is representative Is not only conducive to guiding the development of artificial intelligence technology in the industry Exhibition, but also conducive to the combination of other disciplines and artificial intelligence, to achieve one plus one greater than The effect of two, promote the development of related industries and disciplines. Artificial intelligence technology has It is widely used in all aspects of society. In the current background of rapid economic development and Under the reforming and opening environment, only artificial intelligence technology that suits our national conditions is long For a long time, it will promote the sustainable development of science and technology, sustainable development, sound and rapid development Exhibition. Based on the current situation of laboratory management, this paper mainly studies the application of artificial intelligence technology In the laboratory management of advantages, the main technology, in order to improve and develop artificial intelligence The application of technology in laboratory management is even popularized in the whole society.

2. Methods.

2.1. Laboratory management model based on management process . With the development of the Internet, the information collected in the Internet is timely Feedback to the lab's network platform, through cloud computing and analytics technology, the information Processing, compare the camera data and cloud computing database, handle Cloud computing results, realize the automation of laboratory management, intelligent. The laboratory serves teaching and research work, and its management objects include people, events, materials, information, funds, etc. It involves all activities of laboratory application, construction, and experimental teaching, mainly including: Laboratory construction planning and setup, laboratory management mode and operating mechanism, configuration and use of laboratory instruments and equipment, management of experimental materials and low value consumables, basic laboratory information management and archive management, construction and training of experimental teaching teams, management of experimental teaching and scientific research, and use and inspection of laboratory funds. It can be seen that laboratory management is relatively complex and involves many aspects, but these tasks can be subdivided into specific tasks, from a specific project perspective, the basic model of management work is shown in Figure 2.1 [5].

As can be seen from Figure 2.1, no matter how much management content there is, for a specific project management work, it can be summarized into two steps: "selection" and "action"; "Select" refers to selecting management content, and "Action" refers to generating management results such as reports and emails after appropriate processing. "The operation of selecting management content is actually to limit the content to meet certain requirements, such as when an experimental teacher conducts experimental course management, according to the selected experiment 1 score of 80 or more, moreover, with a theoretical course score of 80 or above and not being a make-up or re major student, the designated students are selected and selected for elective experimental courses. This process is limited to specific experimental objects and can include multiple conditions, the subdivision model is shown in Figure 2.2 [6].

As can be seen from Figure 2.2, through the logical combination of multiple conditions, you can select a management object and then perform corresponding "actions" on the object, "selection" is the basis, and

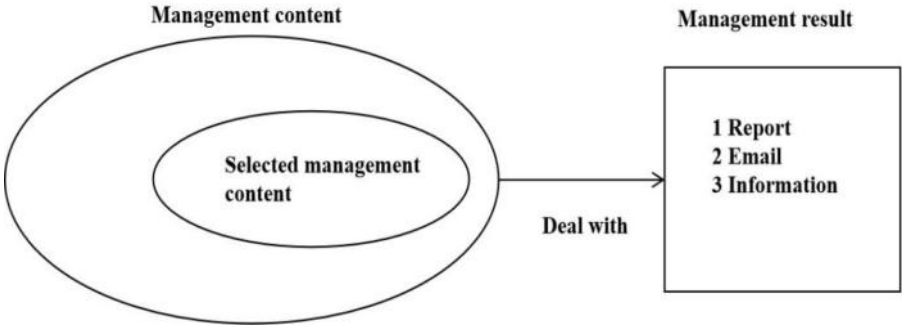

Fig. 2.1: Basic model of laboratory management

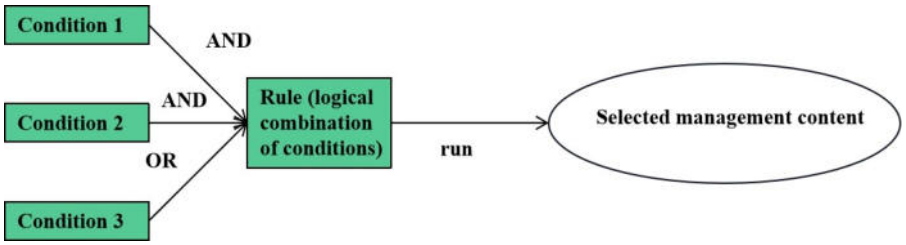

Fig. 2.2: Selection Management Content Segmentation Model

"Action" is the operation based on actual needs. "Selection" is mainly based on various data sources [7].

2.2. Data-driven laboratory intelligent management platform framework . The project function of laboratory management system based on artificial intelligence technology It mainly includes the following: (1) Facial recognition personnel ID and automatic registration information. (2) Intelligent power distribution function. (3) Remote communication.

Facial recognition personnel ID through the facial features collection and recognition function of electronic eye technology, can identify every A person enters the lab, the electronic eye recognizes facial information and sends a message Information processing and existing database for information comparison, record visitor information, to achieve paperless facial registration.

The power distribution function of intelligent system refers to the use of mature solar energy, wind energy and so on Electric technology, to achieve the continuous circulation of laboratory electricity, will not accidentally cut off the movie The development of laboratory work, when the power supply is insufficient, the intelligent system will automatically lift At the same time, through solar and wind power generation technology to achieve the laboratory electricity reserves,

To achieve continuous uninterrupted laboratory power supply effect. Another way of telecommunication That is, the manager of the laboratory can observe the reality through the intelligent monitoring camera Laboratory conditions, improve the observation times, increase the observation duration, in order to timely understand the laboratory The latest internal dynamics, flexible handling of various laboratory situations.

According to the laboratory management model, in order to implement the "select" action, it is necessary to make reasonable use of data to formulate rules, but the specific requirements for each management role may vary, rule making is also different, for experimental teachers, experimental technology, and system managers, their management processes are shown in Figure 2.3 [8,9].

The laboratory management platform is divided into a front-end and a back-end, the front-end uses Web pages for user operations, and the back-end uses logical computing for front-end display. Logic and data support. For a data-driven laboratory management platform, the front-end is used by business personnel in business

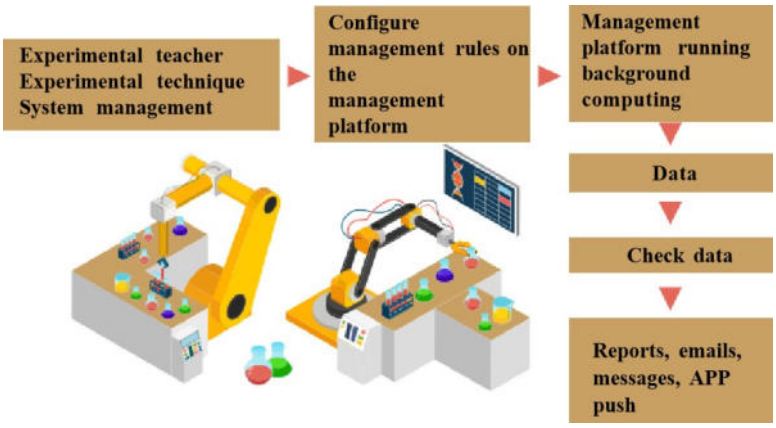

Fig. 2.3: Data-driven laboratory intelligent management process

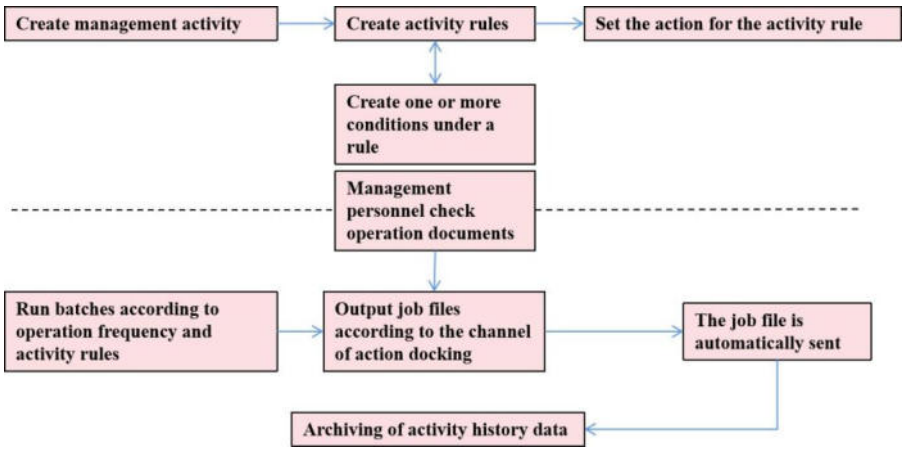

Fig. 2.4: Logical architecture of data-driven laboratory intelligent management platform

departments, such as laboratory teachers and laboratory technicians; The responsible person for the backend is the data engineer and system development engineer in the IT department. According to the laboratory management model, the logical framework of a data-driven laboratory intelligent management platform is shown in Figure 2.4 [10].

Managers log on to the management platform, first create a new laboratory management, set information such as the management name, responsible person, time range, and running frequency, and then create one or more rules under this laboratory management, create different combinations of conditions under each rule, and finally set an action for the created rule. This completes a basic data-driven laboratory management configuration [11].

2.3. Implementation of Lab Intelligent Management Platform Based on Label System . In order to achieve intelligent management on the above management platform, another important step is to set the conditions of activity rules, we use the label system to implement labels, which refer to data labels, which describe entity attributes, the value of the label marks a piece of information about the entity, for example, for a student, ”gender” is a label, and ”male” is the value of this label, which marks the gender information of the student. The label system is a collection of labels that are calculated and stored according to certain rules, it performs class management on labels according to established logic, and calculates and updates label values

Table 2.1: Various laboratory data labels

Label Theme	Base Label	Behavior label	Titles
Experi--mental Courses	Name, course, type (course experiment, open experiment, online experiment), experiment content, goal, first opening time, responsible person	Last Opening Time, Last Opening Number, Hours Opened this Month, Hours Opened this Month, Hours Opened this Semester, number of Users this Semester	The number of days since the first opening, cumulative open class hours, cumulative number of open students, and cumulative extracurricular open class hours
Experimental equipment	Name, manufacturer, production date, price, first use time, storage location, responsible person	Last usage time, last usage time, usage time of this month, usage time of this semester, last maintenance time, performance status	Cumulative usage time, cumulative usage times, open usage times, loan times
Experimental site	Site name and size. Number of work stations, first use time, number of storage equipment, responsible person	Last usage time, last usage time, usage time of this month, usage time of this semester, power consumption data, monitoring access control	Cumulative usage time, cumulative usage times, open usage times
student	Name, date of birth, class, mobile phone number, email address, start date of experiment	Last experiment time, last experiment content, last experiment result, number of experiments this month, content of experiments this semester	Cumulative number of experiments, cumulative experimental hours, in class experimental hours, open experimental hours
teacher	Name, unit, personnel type (full-time teacher, part-time technician), mobile phone number, email address, start of experimental course, time of first course opening	Last experiment time, last experiment content, last number of experiments this month, content of experiments this month, number of experiments this semester	Cumulative number of experiments, cumulative experimental hours, in class experimental hours, open experimental hours

according to rules, data access issues are resolved through pre calculated tags, reducing the threshold for data usage [12,13].

(1) Laboratory Data Label System. The label system is a collection of a series of labels, which can be divided into experimental courses, experimental equipment, venues, students, teachers, administrators, and other topics, these topics are divided into basic tags, behavior tags, and derived tags by data update method, as shown in Table 2.1 [14].

As can be seen from Table 2.1, label topics are divided into basic labels, behavior labels, and derived class labels. The value of the base tag is generally fixed or has a long update cycle, incremental updates are used

Table 2.2: Mapping Table of Label System Hierarchy and Data Backend

Hierarchical structure	Relational database	HBase
Label Theme	Schema	Table Name
Label Type	Table Name	Clan name
label	Column Name	Column Name

to refresh the tag value, updating only tags with changed values each time or inserting newly added customer base tags; The behavior tag is used to describe historical behavior, which is always in change, and adopts periodic full volume updates or real-time (message queue+stream processing) fixed point updates; Derived class tags are logical combinations between other tags, they do not store tag values themselves, but rather store computational logic between tags, the tag value is calculated in real time only when called, which is a special dynamic tag. In this way, experimental data can be converted into label data, and the label system, like the management system, should also be divided into two parts: The front end and the back end [15].

The label administrator uses the front end (management) page of the label system, configure the mapping relationship between the label and the data background, the configuration information is stored in the label mapping Table, after the label user enters query criteria on the front-end (query) page of the label system, the system first locates the physical location of the label through the label mapping Table, then, the corresponding label value is read from the label data background and returned to the page side for display, the label mapping Table is associated with the front-end and back-end of the label system, it stores all attributes in the label system except for the label value, including all description information about the label hierarchy, the backend of the system stores the values of all labels, which are stored through relational database tables or HBase Tables, the label mapping table is shown in Table 2.2, the values of the corresponding labels can be intelligently located based on the information sequence stored in the label mapping Table [16].

(2) Labelled Laboratory Evaluation GBDT Model. In the actual management processes such as laboratory construction demonstration, course effectiveness evaluation, and laboratory benefit evaluation, how to effectively use data pairs for scoring and evaluation is a matter of great concern to all parties, the author adopts GBDT (GradientBoosting Decision Tree) regression algorithm to model the previous experimental data. However, in the GBDT modeling phase, a large amount of computation is required, so the modeling process is completed in the back-end through offline computation, and the established GBDT model is converted into tags for online use. Taking the benefit evaluation of a new laboratory as an example, in the GBDT modeling stage, based on the previously stored student experimental data, performance, equipment purchase prices and updates, equipment usage data, laboratory electricity, access control, and other data, models such as in-class experiment scores, open experiment scores, equipment usage benefit scores, equipment sharing scores, equipment depreciation rate scores, and site operation efficiency scores are established on the server backend, store these models as label data. When evaluating the benefits of a new laboratory, call these models on the Web side and input the application data for the new laboratory, the corresponding score can be quickly obtained for reference by the evaluation experts. The laboratory evaluation is implemented using the GBDT algorithm, with historical experimental data as training data, after training using the GBDT algorithm, the model functions are stored as tags for online invocation [17].

3. Management process example based on label system. The laboratory intelligent management platform implements laboratory management through configuration management rules. The following is an example of pushing selected experiments to outstanding students to illustrate the management process based on the label system, the corresponding table of conditions and labels for this management activity is shown in Table 3.1.

In order to configure this rule, managers need to add the three tags in Table 3.1: iEX_ Scorel iTH_ Score bRE_ EXA sets the corresponding conditions and connects with AND, you can manually edit logical relationships to make adjustments, Table 4 and Table 5 show the key page for rule settings. It can be seen that the label system needs to provide as many public labels as possible to meet as many rule (condition) setting requirements as possible. Once a label user discovers that a label required by the condition does not exist, they

Table 3.1: Condition and Label Correspondence Table

Condition	Corresponding label name	Conditions after converting to labels
Experiment 1 with a score of 80 or above	Experiment 1 Score (EX_Scorel)	iEX_Scorel>=80
Theoretical course score above 80 points	Theoretical Course Score (iTH_Score)	iTH_Score>=80
Not a retake student	Makeup Exam (bRE_EXA)	bRE_EXA("TRUE")

Table 3.2: Label Settings

Label Name	Tag ID	Label Value Type	Subject	Label Type
Experiment 1 Score	35	Integer	student	Behavior label
Theoretical Course Score	36	Integer	student	Base label
A make-up exam	37	BOOL	student	Base label

Table 3.3: Selected Conditions for Management Platform Rules

Condition 1	Experiment 1 Score	>=	80	Delete this condition
Condition 2	Theoretica Course Scorel	>=	80	Delete this condition
Condition 3	A make-up exam	==	TRUE	Delete this condition

need to submit a new label request to the label manager, after the label manager adds the new label to the label system, the label user can see and use the label on the above page of the management platform [18].

When the rule setting page is submitted, the logical relationship corresponding to the rule is saved to the background database, the tag is stored in the form of a tag ID, which allows you to further find the fact Table where the tag is located and obtain the corresponding tag value. If the final logical relationship value is true, it indicates that the student meets the rule; If the result is false, it indicates that the customer does not meet the rule, so the optional experiment is not recommended. The Run Frequency option in the interface is "Every day", which refers to the logical combination of the rules converted into conditions through the page, parse the conditions into SQL statements, perform batch processing in the background, and store the results in a result Table, the subsequent management action stage will produce different formats of job files, or production reports or email job files based on the result Table. In addition to batch processing, you can also choose scenario based management, and management activities can be processed in real-time based on scenarios, for example, after a student has completed Experiment 1 and received a system evaluation score of 80 or more, they can be directly recommended for the experiment. This requires changing batch processing to "real-time processing", the management process is actually consistent, and only technically requires the introduction of "message queues" to complete management based on these messages [19,20].

4. Conclusion. The development of intelligent technology has for the development of our society It plays an important role in applying artificial intelligence technology to laboratory management Now the trend of intelligent and automatic laboratory management. Artificial intelligence technology should Used in laboratory management work, such as facial recognition personnel ID, automatic registration letter The intelligent power distribution function ensures sufficient power supply to the laboratory and prevents accidental breaks The uncontrollable loss caused by electrical accidents can be realized by the remote communication technology of artificial intelligence Laboratory management personnel remotely monitor the internal conditions of the laboratory to find laboratory differences in time Often, take timely measures to nip in the bud. Applying artificial intelligence technology to the real world The development process of laboratory management is not smooth sailing, nor can it be accomplished overnight Need us to give full play to their own subjective initiative, actively contribute to daily life From quantity to quality, the innovation in our science and technology development

and social progress Make contributions and strive to realize the great Chinese Dream. Structured data brings value, and data brings new ideas, with the application of new devices and the Internet of Things in laboratories, there are more and more sources of experimental related data, and more and more management bases are available. Based on the reality of laboratory management, the author studied a laboratory management model. Using a label system to classify and store laboratory data and laboratory evaluation GBDT and other algorithmic models, an intelligent laboratory management platform based on the label system is constructed, realizing batch processing and scenario based laboratory management, the intelligent management platform has strong scalability and can play a role in the entire life cycle of the laboratory.

REFERENCES

[1] Lv X , Li M . Application and Research of the Intelligent Management System Based on Internet of Things Technology in the Era of Big Data[J]. Mobile Information Systems, 2021, 2021(16):1-6.
[2] Shan T , Tay F R , Gu L . Application of Artificial Intelligence in Dentistry:[J]. Journal of Dental Research, 2021, 100(3):232-244.
[3] Galvan P , Fusillo J , Portillo J , et al. PP119 Innovative Screening System For COVID-19 Using Application Of Artificial Intelligence For Telemedicine[J]. International Journal of Technology Assessment in Health Care, 2021, 37(S1):20-20.
[4] Dong Z , Sheng Y , Huang Z , et al. Living Cell Nanoporation and Exosomal RNA Analysis Platform for Real-Time Assessment of Cellular Therapies[J]. Journal of the American Chemical Society, 2022, 144(21):9443-9450.
[5] Chen S , Huang J , Gao Z . Development of Intelligent Management System for High Value Consumable Material in Operating Room[J]. Zhongguo yi liao qi xie za zhi = Chinese journal of medical instrumentation, 2021, 45(1):42-45.
[6] Peng J . Oil Painting Material Collection System Based on Artificial Intelligence[J]. Journal of Physics: Conference Series, 2021, 1852(2):022029-.
[7] Liu Y , Wang Z , Pan Y , et al. Research on Intelligent Monitoring and Early Warning of Electric Power Safety Based on Artificial Intelligence Technology[J]. Journal of Physics: Conference Series, 2021, 1748(5):052046 (5pp).
[8] Kuang L , Liu H , Ren Y , et al. Application and development trend of artificial intelligence in petroleum exploration and development[J]. Petroleum Exploration and Development, 2021, 48(1):1-14.
[9] Ji J , He Y . Application of Artificial Intelligence in Computer Network Technology[J]. Journal of Physics: Conference Series, 2021, 1881(3):032073 (5pp).
[10] Xu K , Wang Z , Zhou Z , et al. Design of industrial internet of things system based on machine learning and artificial intelligence technology[J]. Journal of Intelligent and Fuzzy Systems, 2021, 40(2):2601-2611.
[11] Yang X , Li H , Ni L , et al. Application of Artificial Intelligence in Precision Marketing[J]. Journal of Organizational and End User Computing, 2021, 33(4):209-219.
[12] Lu W . Research on Marketing Development under the Background of Artificial Intelligence Technology[J]. Journal of Physics Conference Series, 2021, 1769(1):012071.
[13] Mase C , Maillard J F , Paupy B , et al. Speciation and Semiquantification of Nitrogen-Containing Species in Complex Mixtures: Application to Plastic Pyrolysis Oil[J]. ACS Omega, 2022, 7(23):19428-19436.
[14] Song Y , Zhao Z , Zheng Y , et al. Investigation and Application of High-Efficiency Network Fracturing Technology for Deep Shale Gas in the Southern Sichuan Basin[J]. ACS Omega, 2022, 7(16):14276-14282.
[15] Gao J , Dong L I , Dan S U , et al. Research Progress on the Extraction Technology of Seabuckthorn Fruit Oil and the Application of Nutritional Factors[J]. Science and Technology of Food Industry, 2022, 43(13):400-407.
[16] Xu X , Li X , Gao X , et al. Application of Large-Scale Molecular Prediction for Creating the Preferred Precursor Ions List to Enhance the Identification of Ginsenosides from the Flower Buds of Panax ginseng[J]. Journal of Agricultural and Food Chemistry, 2022, 70(19):5932-5944.
[17] Zhang C , Du B , Li K , et al. Selection of the Effective Characteristic Spectra Based on the Chemical Structure and Its Application in Rapid Analysis of Ethanol Content in Gasoline[J]. ACS Omega, 2022, 7(23):20291-20297.
[18] Hung H M , Duc L M , Dat N D , et al. Synthesis and Characterization of Polypyrrole Film Doped with Both Molybdate and Salicylate and Its Application in the Corrosion Protection for Low Carbon Steel[J]. ACS Omega, 2022, 7(23):19842-19852.
[19] Cao D , Chen M , Liu Y , et al. Ion Migration in the All-Inorganic Perovskite CsPbBr3 and Its Impacts on Photodetection[J]. The Journal of Physical Chemistry C, 2022, 126(23):10007-10013.
[20] Miskin C K , Pradhan A A , Deshmukh S D , et al. Solution Processed Fabrication of Se–Te Alloy Thin Films for Application in PV Devices[J]. ACS Applied Energy Materials, 2022, 5(3):3275-3281.

Edited by: B. Nagaraj M.E
Special issue on: Deep Learning-Based Advanced Research Trends in Scalable Computing
Received: Dec 20, 2023
Accepted: Feb 27, 2024