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Evaluation on Intelligent Assessment Software of Water Pollution Based on Bayesian Network

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Abstract: With the acceleration of industrialization and urbanization, the irrational exploitation of groundwater resources is increasingly intensified, the pollution problem is becoming increasingly serious, and the water pollution situation is not optimistic. By evaluating the quality of groundwater, people can reflect and grasp the quality and evolution trend of groundwater, thus providing a basis for the protection and development of groundwater, and a correct and efficient evaluation method is a necessary condition to achieve this goal. Due to a large number of monitoring of groundwater quality, there are a lot of unstable factors, making the assessment of groundwater quality become a very difficult problem. At present, the commonly used evaluation methods include single index method and artificial neural network method. The above methods of water quality assessment are applicable to various situations, but when used under the same conditions, the assessment results vary greatly. Fuzzy comprehensive evaluation is currently recognized as the most reliable evaluation method, but its calculation process is relatively complicated, and it is difficult to evaluate it in the case of a large number of samples and indicators. Through the analysis of experimental data, it was found that the probability of water quality reaching the standard was 34%, and the Bayesian network algorithm was of great significance to the prediction and diagnosis of water pollution. Bayesian network algorithm had better effect than traditional algorithm, and was 17.4% higher overall.

1. Introduction

Through the comprehensive application of administration, law, economy, science and technology,

water resources can be effectively managed, so as to achieve the goal of water management. Water resources management is connected with the subjectivity of human cognitive level and the difference of objective reality, which makes various factors uncertain.

In water environment management, it is of great significance to deal with the conflicts of various objectives in a balanced way and to analyze and characterize the uncertainty of them for scientific decision-making of water resources management. Tan Poh Ling believed that water pollution and climate change are rapidly declining in natural attributes, and analyzed the factors that lead to or hinder the successful management of diffuse water pollution [1]. Oral Hasan Volkan provided many methods, such as improving water quality, increasing biodiversity, improving environmental pollution and reducing energy consumption [2]. He Xiaodong found that in addition to phosphide, it is also an important pollutant in surface water, and the change of surface water is controlled by rock weathering and crystal evaporation [3]. Rawat K.S. used geographic information system to assess the groundwater quality of the area and believed that due to the damage of human activities, it is necessary to develop a management plan to control the further management of groundwater in the area [4]. Chen Sophia Shuang used the gradient assessment method to analyze the water quality of urban rivers. Through the study, the following conclusions are drawn: with the rapid growth of population, the pollution trend is increasingly serious [5]. With more policy and financial support from the state, it has played an important role in the development of intelligent water resources management industry, environmental protection, intelligent infrastructure and other fields.

It is increasingly widely used in the comprehensive assessment of water quality. Rizk Roquia analyzed the environmental impact assessment method and compared it with relevant parameters. For data processing, it is necessary to use intelligent technology to improve the water quality of rivers [6]. KiliC Zeyneb believed that the demand for water is also increasing. In particular, the pollution caused by human activities is leading to the reduction of water resources, and a large number of rivers are polluted, so it is necessary to control and detect the river course [7]. Wang Hua has established a water environment model under the framework of volume method to study the driving mechanism of air quality in the river. The results showed that industrial discharge dominates the lake water quality the most, followed by natural pollution [8]. Bisht Anil Kumar mainly analyzed the water quality prediction models of some cities and determined the feasibility of artificial intelligence in the water quality prediction model [9]. Water pollution can be controlled through artificial intelligence technology.

The above research only studies Bayesian network and intelligent assessment of water pollution separately. Although these studies have some reference, they are more or less insufficient to demonstrate the conclusion, and there is a certain room for improvement. In order to solve the application research of Bayesian network in the intelligent evaluation of water pollution, this paper analyzes the development status of sewage water pollution, analyzes the experimental data, and compares the effects of traditional algorithms and Bayesian network algorithms, which has reference significance for the future research of algorithms in other fields.

2. Evaluation of Intelligent Assessment Software for Water Pollution

2.1. Evaluation Status of Water Pollution

In terms of the form of water environmental pollution events, there are mainly unstable factors such as leakage, oil spill, explosion and other unexpected sea areas. Water bodies include rivers, reservoirs, lakes, canals, channels, ponds, etc. The nature of their basins determines the regional nature of their occurrence, and their transmission rates and channels also vary with the different water bodies. In sudden water pollution events, the main pollutants include chemical pollution, oil pollution, cyanide pollution, algae pollution, heavy metal pollution, etc. The uncertainty of the

object of danger and the level of danger, due to the sudden change of the water environment, leads to the decline of the quality of the water environment, which would cause serious environmental problems.

In recent years, because land use and environmental protection are facing serious environmental problems, scientific inter-annual water quality monitoring is the key link for water pollution control and effective treatment. At present, the commonly used assessment methods include single factor assessment method, principal component method and correlation method. These methods use different average levels in the annual water quality assessment while ignoring the complexity of water environment quality and the instability of water body, which leads to inaccurate assessment of water quality and the prediction error of annual change of water quality. Bayesian method is a probabilistic statistical analysis method applied in water quality assessment. The system can integrate the existing knowledge of water quality belonging to a specific water body with the measured data. Using the maximum posterior probability of Bayesian probability reasoning to express the state of water body can solve the uncertainty problem of water body very well. However, in many years of water quality analysis, the traditional Bayesian method also has the disadvantage of using the annual average of each index. Under a single short-term high quality index, the overall water quality of a year cannot be accurately assessed. At the same time, in the analysis of annual changes in water quality, it is difficult to measure the differences and changes of the same type of water quality by the conventional Bayesian method. The probability grade of interval number is used to compare multiple interval values, which is an improvement of the traditional Bayesian algorithm.

For this reason, the concept of interval number is applied to the conventional Bayesian method, and a Bayesian interval annual water quality assessment method is proposed, which evaluates the water quality of various types in the region within the year, and compares the water quality of various types within the year, and puts forward scientific suggestions for the future treatment work. The cause analysis of water pollution is shown in Figure 1.

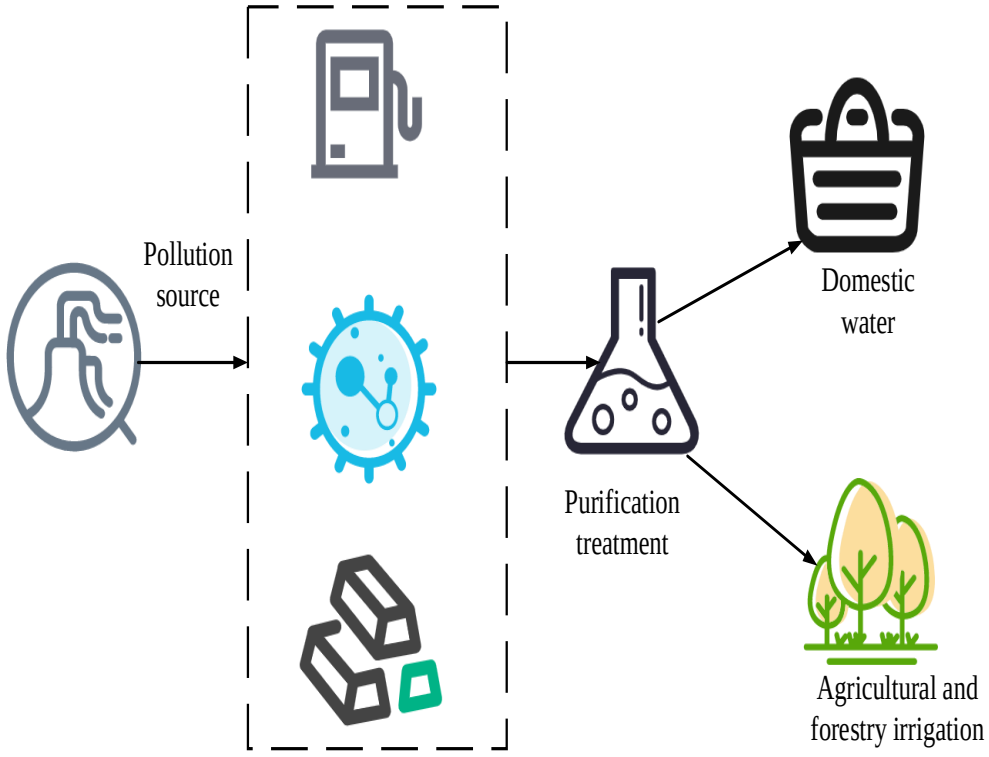


Figure 1. Cause analysis of water pollution

2.2. Intelligent Assessment and Evaluation of Water Pollution

The environmental protection agency has carried out a comprehensive study on several rivers. According to the statistics of relevant departments, it is found that nearly half of the rivers have been affected to varying degrees. One tenth of the rivers have been seriously affected, and most of the other rivers have been affected to varying degrees. Although the current environmental protection problems seem to have improved in some places, the overall development momentum has declined.

Through the investigation of the research status of main pollutants, it is concluded that the main evaluation indicators at present include Bayesian network method, neural network method, root mean square method and clustering method. Based on the analysis of the above main water quality evaluation indicators, the grey cluster analysis method based on cluster analysis is selected for water quality evaluation. In the case of serious pollution of water resources, people should start from both natural and artificial aspects, and integrate policy and economic benefits to establish an evaluation index to solve the pollution problem in the water resources environment. The cluster factors of each index are obtained by using acid-base value processing, dimensionless data processing, cluster weighting, and whitening factor calculation, and the key water bodies are classified by cluster factors.

Secondly, on the basis of learning the prediction model, the gray prediction model that is different from the black and white models is selected. The gray prediction method is used to predict the pollution tendency of the main pollution sources, and the prediction effect is verified. The software is used to evaluate, analyze and predict the important pollution sources, and contribute to the water environment protection work. Relevant scholars focused on the application of identification technology in aquatic production, mainly involving biological identification, species classification, behavior analysis, breeding decision, size or biomass estimation, water quality prediction, etc., aiming at providing scientific researchers and practitioners with strong support for the promotion of intelligent fisheries [10].

Relevant personnel have analyzed the methane gas naturally generated in the landfill area, and these gases are from recent and past drilling in the garbage dump. The hazard degree, potential fire and explosive hazard degree related to methane is smaller than that of gas. A set of methods that can realize remote detection and monitoring of methane emissions from landfill sites has been established [11]. The principle of intelligent assessment of water pollution is shown in Figure 2.

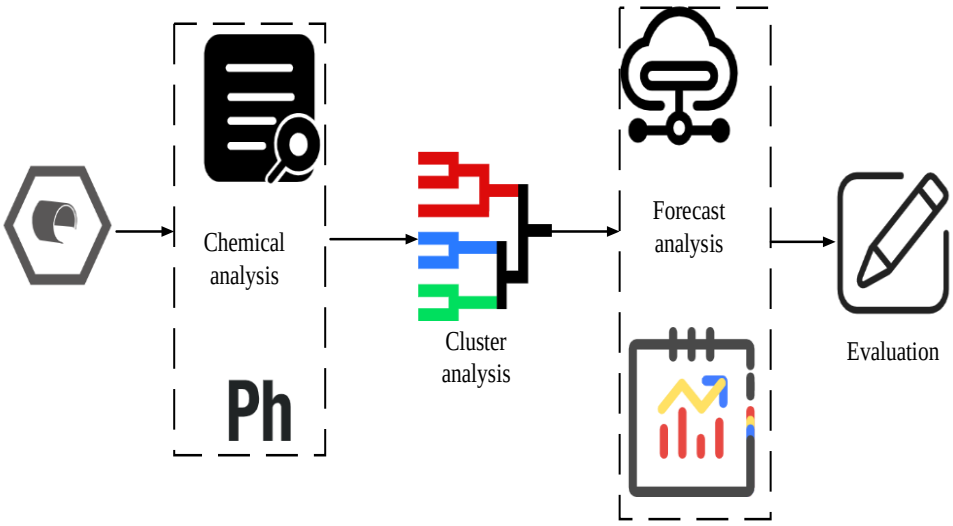


Figure 2. Principles of intelligent assessment of water pollution

2.3. Evaluation Prospect of Intelligent Assessment Software for Water Pollution

In this paper, Bayesian network algorithm is used to evaluate the intelligent software of water pollution, and predict and diagnose various indicators, which has reference significance for the treatment of water pollution. Relevant experts use Bayesian network element analysis to explore the effect of current water pollution control. In practical application, some chemical drugs were applied, and finally it was found that Bayesian network has a good effect on the treatment of water pollution [12]. Relevant personnel applied the additive Bayesian network model to carry out statistical analysis of water pollution samples and evaluate the resistance of various water pollution indicators. A direct relationship between multiple resistant drugs has been found in various types of samples [13].

Relevant personnel proposed a new model-based enhanced teaching architecture, which can reach the human level with less information. Bayesian neural network can be used to capture the causal relationship between factors, so as to predict the transmission of various information in the biological mechanism. This method is easy to explain and can provide robust model risk for system decision-making [14]. Relevant experts have studied various dangerous accidents in the refrigerated distribution system and supply chain. The Bayesian neural network is used to simulate the factors and determine the main influence factors and sensitivity of each factor [15]. Based on Bayesian network, relevant experts have established a new corrosion risk assessment and maintenance decision-making model for water pollution pipeline under external environment. It is necessary to build a decision-making model based on the optimal function, which combines the maintenance strategy with the risk of post-maintenance, and can also reduce the loss caused by external corrosion protection [16]. The research prospect analysis of intelligent assessment software for water pollution is shown in Figure 3.

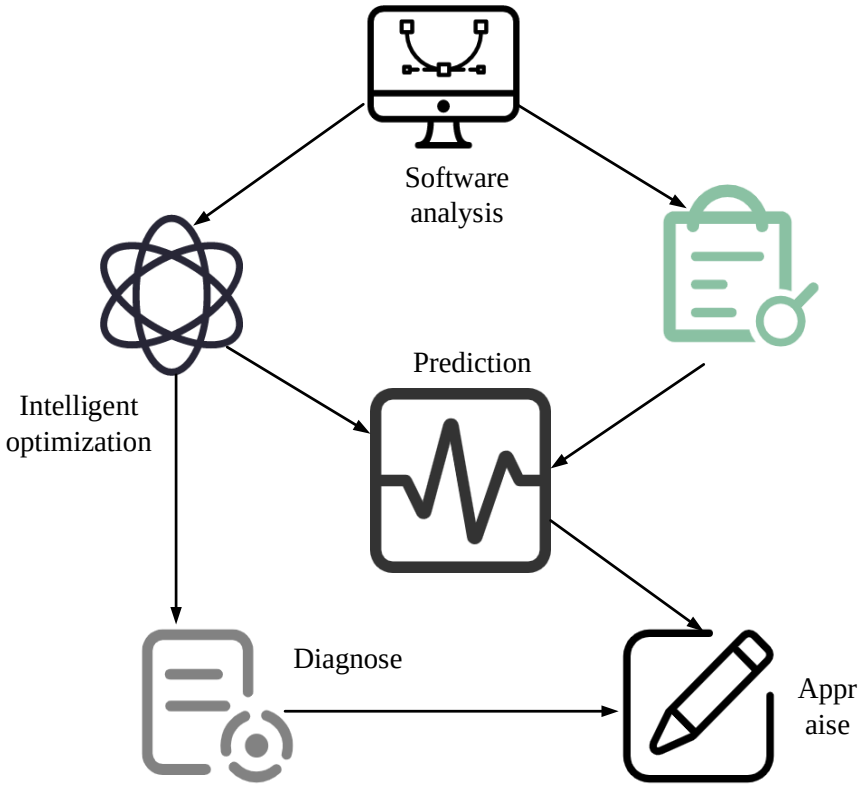


Figure 3. Analysis of the research prospect of intelligent assessment software for water pollution

3. Bayesian Network Algorithm

Bayesian Network (BN) is an aperiodic directed graph that represents the probability correlation of random variables. It is a basic structure for reasoning and analysis. This method uses a simple and clear graphic mode to represent the interaction of various elements, thus making the complex relationship between various elements more logical and understandable. Bayesian Network (BN) is a group of directed acyclic graphs. The expression of its information includes two categories: the first category is network, that is, directed acyclic network, in which each node represents a variable, and the directed arc between each node is the causal link between them. From the production point to the node, it shows the knowledge nature of the domain. The second is the model parameters of the network, which is a possibility table of the state, and reflects the quantification of the variable uncertainty of the Bayesian network.

Assuming that the set of conditional probability distribution of all nodes is P, there are:

$$P(X_1, X_2, ..., X_N) = \prod_{i=1}^{N} P\left(X_i | A(x_i)\right) \tag{1}$$

Among them, $X_1, X_2, ..., X_N$ is all nodes, and all parent nodes are represented by $A(x_i)$.

The sample space is R; B is the event in R; $A_1, A_2, ..., A_n$ is the sub-interval of R.

$$P\left(\frac{A_i}{B}\right) = \frac{P\left(\frac{B}{A_i}\right)P(A_i)}{\sum_{j=1}^{n} P\left(\frac{B}{A_i}\right)P(A_i)} \tag{2}$$

After the Bayesian network is established, the probability calculation is performed on Formula (2):

$$P\left(R|G=g\right) = \lambda \sum_{x-(R \cup G)} P(x) \tag{3}$$

Among them, λ is a constant and G=g is the parent node variable set.

4. Intelligent Assessment Experiment of Water Pollution

4.1. Experimental Method

By selecting water quality pollution samples from 10 regional rivers, the Bayesian network algorithm was used to predict and diagnose the water quality indicators of these 10 regions, and the data results were compared and recorded to provide reference experience for future water quality improvement.

4.2. Data Evaluation

4.2.1. Prediction and Evaluation of Various Water Quality Indicators

Ten river water pollution samples were selected and analyzed using Bayesian network to compare the pollution of various water quality indicators. The prediction and analysis of various water quality indicators are shown in Table 1.

Table 1. Prediction and analysis of various water quality indicators

Parameter	Score	
	High value	Low value
Water quality	0.72	0.34
Eutrophication level	0.85	0.16
Nitrogen	0	1.0
Phosphorus	0.2	0.8

It can be seen from Table 1 that the nitrogen content exceeded the standard, with a maximum value of 1.0, and the phosphorus content was unknown, with a maximum of 0.8 and a minimum of 0.2. The lowest eutrophication level of water quality was 0.16, and the highest value was 0.85. Through data analysis, it was found that the probability of water quality reaching the standard was 34%. The prediction and analysis of water pollution indicators through Bayesian network algorithm was more accurate and can better reflect the specific situation of water pollution.

4.2.2. Diagnosis and Evaluation of Various Water Quality Indicators

Ten river water pollution samples were selected and analyzed using Bayesian network algorithm to compare the pollution of various water quality indicators. Diagnostic analysis of various water quality indicators is shown in Table 2.

Table 2. Diagnostic analysis of various water quality indicators

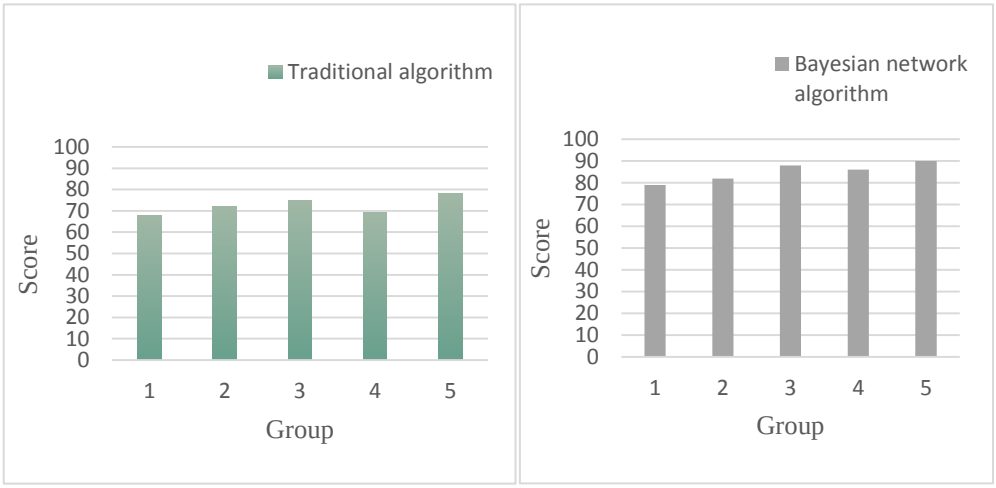
Parameter	Score	
	High value	Low value
Water quality	1.0	0
Eutrophication level	1.0	0
Nitrogen	0.93	0.76
Phosphorus	0.84	0.18

It can be seen from Table 2 that the water quality was in a seriously polluted state through the diagnosis and analysis of Bayesian network algorithm. Through analysis of data, it was found that the eutrophication level of water quality reached the highest value, and the pollution degree of water quality was high. The content of nitrogen was in the range of 0.76-0.93, and the content of phosphorus was in the range of 0.18-0.84. The content of phosphorus and nitrogen in water pollution samples was high. The content of nitrogen was 93%, and the content of phosphorus was

84%. Therefore, Bayesian network algorithm was of great significance in the diagnosis of water pollution. In the treatment of water pollution, nitrogen and phosphorus were mainly purified.

4.2.3. Effect Evaluation of Intelligent Assessment of Water Pollution

The Bayesian network algorithm and traditional algorithm were used to analyze five kinds of water pollution intelligent evaluation software. The higher the score is, the better the evaluation effect is. The comparative analysis of water quality pollution intelligent assessment effect is shown in Figure 4.



(a) Traditional algorithm *(b) Bayesian network algorithm*

Figure 4. Comparison and analysis of intelligent evaluation results of water pollution

It can be seen from Figure 4 that Figure a is the score of the traditional algorithm. The average score was 72.4; the highest value was 78; the lowest value was 68. The overall score was low and the variance was large. Figure b shows the score of Bayesian network algorithm. It can be clearly seen that the score of using Bayesian network algorithm was higher than that of traditional algorithm. The average value of using Bayesian network algorithm was 85, and the score was basically distributed in the range of 79-90, with small fluctuation and good effect. Bayesian network algorithm had better effect than traditional algorithm, and was 17.4% higher overall.

5. Conclusion

Through the analysis of the current situation of water pollution and the intelligent evaluation analysis of water pollution, this paper used Bayesian network algorithm to analyze various indicators of water quality. Bayesian network algorithm played an important role in the prediction and diagnosis of water pollution samples. By comparing the traditional algorithm and the Bayesian network algorithm, it was found that the Bayesian network algorithm was more accurate for the intelligent evaluation of water pollution, and the accuracy rate was 17.4% higher than the traditional algorithm. The prediction and analysis of water quality by Bayesian network algorithm can better reflect the specific situation of water pollution, and the diagnosis efficiency of Bayesian network algorithm for water pollution was high. Through the analysis of various indicators of water quality, including nitrogen, phosphorus, water rich oxidation level and water quality, it was found that the content of nitrogen and phosphorus was high. Therefore, in sewage treatment, nitrogen and phosphorus were mainly purified. The research direction of this paper has reference significance for

future evaluation in other fields using Bayesian networks.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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