Atmospheric environment quality assessment based on improved immune algorithm

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ABSTRACT
Atmospheric quality assessment is an important research subject. In order to control the air pollution and to attract more and more attention for the air quality. This paper has proposed an improved immune clone algorithm and applied to atmospheric quality evaluation. The method constructs the function of atmosphere quality evaluation and optimizes the parameters of the evaluation functions. It can ensure the population diversity and improve the algorithm convergence. Experimental results show that the proposed model is effective and feasible for assessing atmospheric quality. It could provide a new reference basis and approach in the field of environment. Therefore it has great potential in the field of assessment the atmospheric quality.

KEYWORDS
Atmospheric environment; Quality assessment; Immune algorithm.
INTRODUCTION

With the rapid development of the economic, industrialization and the improvement of peoples’ living situation, Atmospheric pollution has shown a serious, diversified development trend, pollution of the air is a threatening all creatures. People gradually realized the importance of protecting the atmospheric environment. Therefore the studies related the atmospheric quality, such as the assessment and forecasting of the atmospheric quality, have become noticeable increasingly. In order to control the air pollution and to attract more and more attention for the air quality. So far, at home and abroad, the many method of atmospheric quality assessment have been putted forward, such as API method, grey clustering method, fuzzy mathematics method, hierarchy analytic method. But these evaluation methods are lack of clear physical hospital, and it is difficult to provide directly scientific basis for environmental renovation planning. Therefore, this paper has proposed an improved immune clone algorithm and applied to atmospheric quality evaluation. The method constructs the function of atmosphere quality evaluation and optimizes the parameters of the evaluation functions. It can ensure the population diversity and improve the algorithm convergence. Experimental results show that the proposed method is the Feasible and effective.

THE QUALITY ASSESSMENT OF ATMOPHERIC ENVIRONMENT

Air pollution is the human activities and natural processes which cause certain substances into the atmosphere. It shows a sufficient concentration and reaches a sufficient time. Therefore It harms to the human body comfort, health and welfare or harms the environment phenomenon. Atmospheric pollutants from the source can be divided into two kinds, natural and anthropogenic pollutants. With the rapid development of the industry and the increasingly frequent of economic activities, especially in the densely populated city and industrial region, the air pollution is pretty heavy. The harm degree which caused by the pollutants on the environment can be represented by the index growth curve formula as S type through the study of the environmental pollution.

The harm rate of pollution of the ith atmospheric pollutant can be expressed as the follows:

\[ R_i = \frac{1}{1 + a_i e^{-b_i c_i}} \]  

where \( a_i \) and \( b_i \) are parameters related to the ith pollutant, and \( c_i \) is the measured density of the ith pollutant. Parameter \( c_i \) can be replaced with a relative density, namely, \( x_i = c_i / c_{i0} \), where \( c_{i0} \) is a predefined parameter of the ith pollutant, usually taken as the natural basic density of the ith pollutant. The 3 parameters a, b, c are the universal parameters to be determined which has no relationship with The characteristics of pollutants.

THE IMPROVED OF IMMUNE CLONAL SELECTION ALGORITHM

In this paper, immune clonal selection algorithm is integrated with vaccine autonomous obtaining and vaccination operator. In the process of affinity maturation, one vaccine is produced via memory set of population, meanwhile, vaccine library evolves, and then, new generating individuals are vaccinated using vaccines in vaccine library before they are entered into next generation population, which can maintain the diversity of population, enable the population to evolve with a guided manner instead of random manner and accelerate affinity maturation process.

1) The dimension of clonal antibody

In the good memory was cloned, according to clone size the clone is processed According to the problem of the different, the scale of clone antibody is not the same. The calculation formula of the antibody clone size is as the follow.
\[ n = p * \text{int}(\sqrt{N/1}) \] (2)

Where, \( P \) is the constant parameters of cloning, \( \text{int()} \) is a function of getting integer. \( N \) is the population size, \( I \) is the ranking number of affinity.

2) **The vaccine extraction**

Through the introduction of vaccination, excellent antibodies are preserved in antibody variation process, so as to improve the superior production. In the improved immune clonal selection method when each iteration occur, Antibody in good memory \( X_{sp} \) is as a candidate vaccine set, candidate vaccine is named as \( X_{ip}^j(p, p_2, \cdots, p_n) \), where, \( i \) is the sort number of antibody affinity about the merits \[^7\].

3) **The vaccine Selection**

The vaccine selection is a roulette wheel selection strategy

\[ P_i = F_i / \sum_{i=1}^{M} F_i (i = 1, 2, 3, \cdots, M) \] (3)

Where, the affinity is \( F \). The population is \( M \)

**ATMOSPHERIC ENVIRONMENT QUALITY ASSESSMENT BASED ON IMPROVED IMMUNE ALGORITHM**

1) **Constructing the objective function**

According to the 5 ambient air quality standard (GB3095-1996), The 7 kinds of pollutants is listed in the standard, \( C_{i0}, C_{i1}, C_{i2}, C_{i3} \) and \( C_{i4} \) are defined as Level 0, level 1, level 2, level 3 and level 4. Therefore, the objective function is established. as follow.

\[ \min f(x) = \min \left\{ \sum_{k=0}^{K} \sum_{i=0}^{m} (R_{ik} - R_{ki})^2 / K_m \right\} \] (5)

Where, The parameter \( m \) refers to the kinds of pollutants; parameter \( K \) refers to the classification level of atmospheric pollution; parameter \( R_{ik} \) refers to the damage rate of \( K \) level about \( I \) pollutants pollution, the parameter \( R_{ki} \) refers to the goal value of \( K \) level pollution Damage.

**Step of the algorithm**

Input: antigens set (training set).
Output: are the memory set and the parameters

**Step1**: using real coded"

**Step2**: \( N \) is randomly generated. It is made up initial antibody population \( X(0) \)

**Step3**: to calculate affinity \( f \) according to the objective function

**Step4**: if It is satisfies certain number of iterations or reaches a predetermined accuracy, the algorithm terminates, otherwise executing step 5.

**Step5**: according to the degree of affinity \( f \), antibody population size will be divided into two antibody group, the selection of high affinity \( f \)

**Step6**: According to the degree of affinity \( f \) antibody population size will be divided into two antibody group, the selection of high affinity part of the antibody is an excellent memory, Other Is general antibody units.

**Step7**: All antibody in good memory refer to candidate vaccine antibody
**EXPERIMENTAL RESULTS AND ANALYSES**

In order to test and verify Atmospheric Environment Quality Assessment Based on Improved Immune Algorithm, we did simulation experiment. According to the assessment of atmospheric quality objective function formula 5, the paper uses improved Immune clonal selection algorithm to optimize parameter a, b, c for atmospheric pollution damage rate. When antibody 100 are randomly generated and the iteration selected is 30 times. The value of the top 20 in the parameter a, b, c are TABLE 1.

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Figure 1: The experiments for two algorithms
Figure 1 shows that the experiments for two algorithms were run for 10 times, generic clonal selection and improved clonal selection algorithm integrating with vaccination operator. The improved algorithm uses vaccination operator to increase the speed of convergence.

Figure 1, the affinity process of antibody population in the improved clonal selection algorithm is faster than that in generic clonal selection algorithm along with increasing evolutionary generations

CONCLUSIONS

The experimental results obtained show that the proposed improved immune algorithm is feasible and effective for the assessment atmospheric quality. Because the values of parameters \( a \) and \( b \) for calculating the harm rate of the atmospheric pollution are uniform for different pollutants, the proposed method could have more advantageous when the number of pollutant kinds is more. Since the assessment of the atmospheric quality is performed according to the density values of multi-pollutants and the assessment criterion is according to the average density of multi-pollutants, therefore the assessing process is more objective and has clear physical meaning. Satisfactory results obtained show that the proposed method is effective and applicable for the assessment of atmospheric quality.

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