The abnormal precipitation in rainy season based on genetic algorithm and the security of big data in network

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Abstract
In this paper, cloudsim cloud simulation tool is studied, and its running environment is reasonably configured. Taking the platform as the background, the improved genetic algorithm proposed in this paper is used for simulation experiment that is to optimize the genetic algorithm through simulated annealing behavior. Through the simulation experiment of the improved genetic algorithm, it can be known that the genetic algorithm designed in this paper can satisfy multiple customers one by one and has a certain improvement effect on cloud service quality. In this paper, the problem of rainfall anomaly in city D is studied. The results show that the rainfall anomaly of city D is related to solar activity, 500hPa height field in winter and SST in the Central South Pacific from June to August of the previous year. It is found that there is almost no rainfall during the high solar activity years, while there is frequent rainfall near the low solar activity years. Finally, according to the homomorphic encryption mechanism, this paper studies the protection of data confidentiality in computer network security and the multistorage technology of big data. In this research scheme, by adding a certain number of virtual objects to two different computing information dummies, we successfully protect the data such as the number of items owned by the data owner, the content of the items owned, and the item objects called by the user. In addition, this paper uses bilinear mapping and RS coding technology to create related protocols to solve some problems, such as infinite verification of big data integrity, error data recovery, and protection of data owner’s computing resources. Through the design of solutions to the above problems, this paper successfully completed the protection of big data resources and network security based on cloud computing environment.

Keywords Genetic algorithm · Abnormal precipitation in rainy season · Network security · Big data

Introduction
In order to solve the premature problem of genetic algorithm, this paper uses simulated annealing genetic algorithm to optimize it. Simulated annealing genetic algorithm (SA-GA) captures the solid-state physical annealing mechanism and has the ability to jump from local solutions. It is a global optimal algorithm. However, the disadvantage of this algorithm is that it knows little about the whole search space (Tiwari et al. 2009). The combination of genetic algorithm and simulated annealing genetic algorithm can give full play to their advantages, and eliminate the shortcomings of the two algorithms at the same time, so as to improve the performance of the algorithm itself (Voss et al. 2013). In this paper, the annealing simulated physical calculation factor is introduced to generate new individuals. The simulated annealing genetic algorithm of metropolis standard is used to determine whether new individuals are created in the above operations (Scanlon et al. 2012). It not only ensures the diversity of the population, but also promotes the population growth. Based on this point, through the analysis of the characteristics of climate and precipitation in D City, this paper focuses on the main factors affecting the precipitation anomaly in rainy season and the characteristics of air circulation anomaly (Sultan et al. 2013). The results show that the precipitation in D City has obvious seasonal characteristics (Woolf et al. 2003). July and August...
account for more than half of the total annual rainfall, and heavy rainfall events often occur in D City in these two quarters (Sultan et al. 2019; Xavier et al. 2010). The change of precipitation in different years is different, but it shows a decreasing trend for more than 40 years. Among them, the city has different precipitation cycle characteristics every quarter, and the precipitation anomaly in rainy season includes different oscillation cycle values of $2–3$, $10–12$, and $20–22$ years. Finally, on the basis of network security computing, this paper makes in-depth research on big data security and privacy protection. This paper starts with the security mechanism based on cloud computing environment and shows the role and importance of cloud computing security encryption mechanism in the process of cloud platform big data processing and data computing. The cloud platform uses the default mechanism described in the previous article, which is compatible with the privacy protection scheme design of cloud data storage and the storage itself (Yousif et al. 2020). Based on this, this paper proposes an improved data storage scheme (Swenson and Wahr 2009). In this scheme, if the information thief wants to steal the relevant data, he must know all the data information of the relevant matrix, which is of great significance for the protection of network security and confidentiality. In addition, the data computing program has been extended and implemented around four cloud servers (Swenson et al. 2008).

Materials and methods

Data source

The general data used in this paper include the monsoon monitoring data from northern China, IOBW index, 88 traffic indexes, 26 sea temperature indexes, and a total of 130 climate indexes provided by NCEP/NCAR, NOAA, CMA, and NCC. The dataset provided by each platform covers a wide range of time (1970.1–2020.12).

Genetic algorithm design

The stronger the adaptability of genetic algorithm, the greater the chance of survival. In the process of searching, the algorithm can adjust, search, and compare the running iterative calculation, so as to select the appropriate individuals in the process of genetic evolution to realize the change, which is convenient for the next generation to have more adaptive genes (Tapley et al. 2004).

The process of making genetic algorithm determines the process of recombining a single gene. The flow of basic genetic algorithm is shown in Fig. 1.

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Fig. 1 Flow chart of basic genetic algorithm

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Algorithm design of rainfall anomaly in rainy season

The formula (1) can be obtained from the correlation linear regression.

\[ x_i = a + bt_i (i = 1, 2, \cdots n) \]  

By analyzing Eq. (1), it is concluded that a and b can be estimated by least square method.

\[
\begin{align*}
    b &= \frac{\sum_{i=1}^{n} x_i t_i - \frac{1}{n} (\sum_{i=1}^{n} x_i) \left(\sum_{i=1}^{n} t_i\right)}{\sum_{i=1}^{n} t_i^2 - \frac{1}{n} \left(\sum_{i=1}^{n} t_i\right)^2} \\
    a &= \bar{x} - b \bar{t}
\end{align*}
\]

Among them:

\[ \bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i, \bar{t} = \frac{1}{n} \sum_{i=1}^{n} t_i \]  

To create a sequence:

\[ s_k = \sum_{i=1}^{k} r_i (k = 2, 3, \cdots, n) \]

Among them:

\[ r_i = \begin{cases} +1 & \text{when } x_i > x_j (j = 1, 2, \cdots, i) \\ 0 & \text{else} \end{cases} \]

Assuming that time series are free random, statistical data are defined:

\[ U_{F_k} = \frac{s_k - E(s_k)}{\sqrt{\text{Var}(s_k)}} (k = 1, 2, \cdots, n) \]

If the above formulas are independent and continuously distributed, they can be calculated by the following formula:

\[ E(s_k) = \frac{n(n+1)}{4}, \quad \text{Var}(s_k) = \frac{n(n-1)(2n+5)}{72} \]

The advantage of this method is that it is not only easy to calculate, but also can clarify the start time of the change and concentrate the mutation area without disturbing some previous values.

Results

Characteristic analysis of precipitation anomaly in rainy season

The percentage of precipitation for each season and from July to August in different areas up to the annual precipitation is shown in Table 1.

It can be seen that the seasonal distribution of precipitation in D City is similar and different in the whole province and even the whole area of D province.

The similarity is that the precipitation time is mainly concentrated in summer and accounts for half of the annual precipitation. Therefore, the precipitation characteristics from July to August mainly represent the precipitation characteristics of the region. The order of precipitation in each season is summer > autumn > spring > winter. This is the same in all regions. From the specific rainfall of each season, city D is different from the whole city and the whole province.

Since drought is usually caused by insufficient rainfall, in order to better understand the seasonal characteristics of heavy rainfall anomaly in D City, we calculated the monthly positive anomaly frequency in the past 40 years (see Table 2). The seasonal variation of precipitation anomaly in D City, whether the rainfall is positive or negative, the highest value is always in
August. The frequency of negative anomaly is 113, and that of positive anomaly is 85; According to the annual data, the frequencies of negative and positive anomalies in July are 104 and 81. It is followed by June, September, May, April, November, and October. There are almost no abnormal precipitation events from December to February in winter. From the above analysis, it can be seen that the periodic change of heavy rainfall abnormal events in city D is of great significance to the positive and negative abnormal events from June to September. Drought disaster may occur. In addition, the probability of drought is higher than that of flood in D City from June to August, but the opposite is true in September.

In order to determine the distribution of precipitation and drought years in rainy season of city D, the observation results are listed in Table 3.

As can be seen from Table 3, 9 years have been rain years in the past 40 years, and 10 years are dry years. The 1960 was rainy season, while the 1990 was a dry year, which also showed a downward trend in autumn rainfall in the past 40 years, which is consistent with the results of relevant studies.

**Climatic characteristics of early and late rainy season**

Figure 2 shows the year-on-year change, linear trend and 9-year average change of the initial data of precipitation anomaly (OSDRS_NC) in North China from 1970 to 2020.

Figure 3 shows the time series of the beginning and end of the rainy season in northern China from 1970 to 2020.

According to previous studies, from the late 1970s to the early 1990s, the rainy season in northern China started late and ended early, and the rainy season was short, resulting in severe drought in northern China. After 2005, the rainy season in northern China ended later, and the number of rainy seasons increased until autumn. The correlation coefficient analysis is shown in Fig. 4.

It can be seen from the figure that there is an important positive correlation between northern China and Northeast China. In July, the western subtropical jet in East Asia is mostly located at 40°N. Figure 5 shows the time and latitude distribution (average 110–140 °E) of the 200 hPa zonal wind in East Asia during the early and late period of the northern monsoon in China.

In the first few years (Fig. 5a), from the end of June to the middle of August, the positive anomaly at 40 °N and the negative anomaly at 40 °N indicate that the jet in the west jumps early. In the following years (Fig. 5b), there was a positive anomaly from the end of June to the middle of July, 40 °N is a negative anomaly to the south.

As shown in Fig. 6, the tropical Indian sea has a significant positive correlation with the similar range in spring (Fig. 7b) of SST related to the mountain from March to May, and is positively correlated with the area between Indian Ocean. The central Pacific and Eastern equator are higher, and the maximum value in the middle is more than 99% confidence, and significant negative correlation regions are found in the North Pacific. In the summer SST correlation set (Fig. 7C), there is still an important positive correlation in the tropical Indian Ocean. The relevant areas become denser than in spring. The center of the highest value is more than 99% confidence. Important related areas can also be found in the central Indian Ocean, which has the largest value and exceeds 99% confidence. The significant negative region associated with the North Pacific in spring disappeared in summer, and the positive region related to the Pacific became larger. It shows that when El Nino phenomenon first appeared in spring, if the Indian Ocean warming in spring and summer, the rainy season in northern China will start later; If not, it would be too early.

**Interannual and interdecadal characteristics of rainfall in rainy season**

Figure 7 compares the rainy season in northern China from 1970 to 2020 and the time series of summer (June to August) precipitation in northern and central China (July and August).
The results of rainy season in northern China are significant, but the interdecadal characteristics are not as significant as the results of other two consecutive precipitation time series. As a result, $m$-$k$ tests three sets of rainfall time series. In northern China, there are four series of rainy days in summer. The oscillation occurs every 6 years, and the rainy season in northern China has an interannual oscillation of 4 years. Further calculation of the correlation coefficient of the three datasets shows that the correlation coefficient between precipitation in northern China and summer precipitation in northern China is 0.78, which has passed the 99% significance test. This is because the rainfall in northern China mainly occurs in July and August. By calculating the rainfall coefficient in northern China, we can find the summer rainfall balance (Fig. 8).

Fifty percent of the summer precipitation in North China comes from the rainy season, and 60% of the midsummer precipitation in North China comes from the rainy season. This is similar to previous studies. The rainy season is the most important summer rainfall in North China. The forecast also shows that there are summer drought and flood disasters in northern China. The 11-year sliding correlation between rainy season rainfall in northern China and summer and midsummer rainfall in northern China was calculated (Fig. 9).

The consistency of rainy season precipitation with summer and midsummer precipitation in northern China has obvious interannual and interdecadal characteristics. Before the 1970s, the coherence between the two was very strong, but it continued to the 1980s after the 1970s. Between 2000 and 2006, the relationship between the two weakened. In the past 61 years, the relationship between the rainy season in northern China and the summer and midsummer rainfall in northern China is changing rapidly.
In the past 100 years, the rainy season in northern China has undergone two major interdecadal changes. In the mid and late 1960s, rainfall decreased in northern China, and after the 1970s, it increased. In the previous paper, we observed the weather map of rainy season in northern China from 1970 to 2020 and found that the characteristics of interannual and interdecadal climate in North China are completely different. Therefore, the sliding $t$ test is used to calculate the precipitation series in northern China. The monsoon rainy season shows that the rainy season in North China experienced an obvious sudden change in 1996, from heavy rainfall to less rainfall (Fig. 10). Before 1996, there was a heavy rainfall period with an average rainfall of 157.6 mm. After 1996, the rainy season is less, with an average rainfall of 117.6 mm, 40 mm less than before, while the average annual rainfall during 1970–2020 is 136 mm. It can be seen that in 1996, the rainy season in northern China experienced interdecadal changes, with less rainfall at the end of the year. In order to further prove this conclusion, the accumulated chart is represented by rainfall over 57 years in northern China (FIG. 11). It can be seen that the precipitation changed greatly before and after 1996.

Comparing these charts to provide the correlation coefficients between the sea water temperature in spring and winter, and between the sea water temperature in June and July and the precipitation in last winter (Fig. 12), the analysis shows that the sea water temperature in last winter has changed. Spring has little effect on rainfall in North China, especially in June, and the effect of SST in July is even more obvious. In the previous chapter, the Indian Ocean sea surface temperature affected the beginning of the rainy season in North China but had a weak relationship with the rainy season in North China. It has also been shown to affect monsoon rainfall and rainfall in northern China, and the number of factors is inconsistent.

The study found that the most relevant month was June, and the correlation coefficient was 0.44, which was 99% higher than the significance test. Therefore, in order to better
study the influence mechanism of SST on rainy season in northern China, regression method is used to calculate the distribution map. In NINO3 sea level index, the high field is 500 hPa, and the circulation is 850 hPa from 1970 to June 2020. Within 500 hPa, the Pacific is an important positive area. At 850 hPa, there is a significant positive region from South China to Northeast China. This indicates that the SST of the Pacific Ocean will affect the SST intensity and location of the tropical Pacific Ocean in West Asia and East Asia in summer, which will affect most of the rainy seasons in northern China as shown in Fig. 13.

Discussion

Theoretical basis of big data security and privacy protection technology in cloud computing

Genetic algorithm is the main branch of evolutionary calculus. The basic idea of evolutionary algorithm is from simple to complex, from the lowest level to the highest level of biological evolution process. The algorithm also corresponds to the parallel optimization process of nature. The evolutionary purpose of biology is to adapt to the environment (Abotalib et al. 2016). Compared with the traditional algorithm, the algorithm has many characteristics, such as organization, adaptability and learning, and has a high robustness. Therefore, it is widely used in various occasions and fields. It is often used to solve complex evolutionary problems, and it has the high superiority that the general algorithm cannot achieve (Abdelmalik and Abdelmohsen 2019). The calculation steps of the algorithm are as follows:

Step 1: Initialize the team and provide a series of preliminary solutions;
Step 2: Calculate the adaptive function values of the individuals in the relevant group and evaluate them;
Step 3: Judge the solution obtained in step 2, and complete the calculation if it meets the requirements or has reached the specified iteration times; Meanwhile, if the requirements are not met, skip to step 4 for execution;
Step 4: According to the evaluation results of step 2, according to the specific rules, select a specific solution from the current solution as the element of the next genetic operation;
Step 5: Perform genetic operations on the solution selected in step 4 (including crossover and mutation) to obtain a new set of solutions, and then go to step 2.
Evolutionary computing is a random search algorithm. In evolutionary computation, random processing is used in the process of generation, selection, hybridization, and transformation of initial population and other gene manipulation.

Genetic algorithm is derived from the evolutionary thought of biological world, which is mainly based on the genetic mechanism of genetic mother in the process of biological reproduction and the natural selection mechanism of “survival of fittest” (Ahmed and Abdelmohsen 2018). It has the global parallelism and the remarkable characteristics in the global search optimization algorithm of spatial search. In addition, genetic algorithm does not need origin and mathematical continuity to move, but can move structural objects directly, so they have a wider range. The inherent similarity of genetic algorithm makes it more suitable to find the best solution globally. At the same time, by introducing probability method, genetic algorithm can adjust the search direction and find the best solution in space.

Genetic algorithm has the following characteristics:

- The search space of genetic algorithm is a combination of solutions for problems, not a single solution. Therefore, it has a wider search range and allows parallel search at multiple points. This makes genetic algorithm able to process and analyze multiple solutions simultaneously, and search has a greater breadth and efficiency, so as to avoid falling into the best single peak local solution and lead to the efficiency decline.

- There are different ways to code each. There are different patterns of individual coding in genetic algorithm, such as real number coding, small string coding, command string coding, and structure coding. Because coding can directly describe and manipulate structural objects (such as sets, tree views, and graph lists), genetic algorithms can be easily used to solve them (Crowley et al. 2008).

- Parallelization is easy to implement. The unit of operation of genetic algorithm is population, and there are many individuals in the population. Therefore, in the process of algorithm, no matter how old it develops, genetic algorithm can perform the same search in several regions. For parallel machine or distributed system, genetic algorithm can be distributed well to deal with it effectively, and has the advantage of obtaining additional benefits at low cost (Feng et al. 2013).

- Genetic algorithm is easy to implement. Genetic algorithm does not need to use a lot of information in search space. It checks individual populations by using fitness function as the basis of genetic operations. Fitness function is not limited by search restriction (such as variability, continuity, and repeatability), which makes genetic algorithm easy to implement.

- Genetic algorithm uses probability transfer rules to determine the direction of searching and developing algorithm (Fenoglio-Marc et al. 2012). Compared with the use of deterministic rules, this method reduces the amount of information needed for each stage of search operation. At the same time, because the selection of individuals in genetic algorithm only distributed well to deal with it effectively, and has the advantage of obtaining additional benefits at low cost (Feng et al. 2013).

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refers to the number of adaptive functions, so as to design reasonable adaptive functions to evaluate the evolution of individuals, genetic algorithm can continue, which makes genetic algorithm more practical in practical application.

Analysis of the requirements of privacy protection system

Big data is an important data resource in today’s society. By using cloud computing to extract and analyze a large amount of data and predict the future direction of the object according to the analysis results of the object, the result of this paper can achieve the effect of twice the effort. Nowadays, more and more industries rely on big data. People enjoy the comfort of various intelligent aspects in their lives and also the result of a large number of calculations and analysis of data. Therefore, the importance of big data can be imagined. Cloud computing is an open environment (Ferreira et al. 2012). When users upload private data to the cloud, the security and privacy of the transmission are the most concerned issues. Many privacy leaks in 2019 show that it is very urgent to protect high data security and privacy in cloud environment, so it is necessary to design a privacy protection system. Cloud computing has the characteristics of flexibility, powerful computing ability, and high scalability. It combines cloud computing encryption technology to achieve outstanding data security and privacy protection goals in cloud computing environment (Hegazy et al. 2020). This chapter will combine the conclusions of previous chapters to analyze the feasibility model of privacy protection system.

In order to analyze the system, it is necessary to analyze it from three aspects: security, scalability, and economy.

Security

The security and privacy of big data in cloud environment is a problem that hinders the development of cloud computing and big data itself (Kusche et al. 2009). This is the main problem that users who use cloud computing. In order to ensure the security of private data transmission in the cloud, this paper uses the enhanced AES algorithm and secret SM2 algorithm to encrypt the private data to be transmitted, and adds the data integrity verification function to further shorten the transmission time and security of private data. Finally, the secret and ciphertext keys are saved separately to ensure the security of private data storage to some extent.

Scalability

Private data transmitted by different users is different, so more private user data will be added. The public cloud storage capacity is large, and the innovation ability is strong, which can meet the needs of system expansion (Mohamed et al. 2016).
Economy

Today, cloud services provided by merchants are portable, light, and cheap and can also provide after-sales services so that the individual economy can fully bear it.

The user’s requirements for the operating system are the inspiration for designing the privacy system. Before using the system, different users must log in to verify their identity (Othman and Abotalib 2019). If private data is uploaded, the uploaded content must be encrypted, and the downloaded content must be decrypted. For users who need to use cloud computing to perform data calculation, the results of data calculation are classified into confidentiality category, and the transmission of calculation results also needs to be encrypted.

The speed of transmission and storage of private data in cloud computing depends on the speed of network environment (Rateb and Abotalib 2020). The speed of encrypting private data depends on the creation of the algorithm. SM2 and AES encryption scheme are improved, which improves the encryption and decryption speed while ensuring the

**Fig. 11** Precipitation accumulation anomaly in North China from 1955 to 2020

**Fig. 12** Distribution of correlation coefficient between rainfall and SST in rainy season in North China from 1970 to 2020
security. In addition, users can choose whether to encrypt the uploaded data files, which further solves the efficiency of data processing in the system.

Privacy protection performance and security analysis

Performance analysis

The test environment is window7 system, the CPU is Interl corei5-2450m (2.50hg), and the memory is 6GB. After user registration, symmetric key exchange is completed. When entering the system to upload private data and other operations, the main considerations are the enhanced AES encryption and decryption time, and the time to calculate the hash value (Rodell et al. 2009).

First, it takes time to test the decryption with the improved AES algorithm. Most big data has a large amount of information and contains private data. Therefore, this section uses a 128-bit symmetric key to pair private.Txt files in 512 MB. The test data results are shown in Table 4. The results show that when the data size is 512 MB, the time of encryption and decryption is less than 1.4 s, which is acceptable.

Then, the calculation time of hash value of the system is tested, and the private data file.Txt in 512 MB is tested and compared with SHA-256 algorithm. The test results are listed in Table 5.

Safety analysis

It can be analyzed from two perspectives: encryption technology and cloud computing platform.

Encryption technology perspective The improved AES algorithm uses double symmetric key, which improves the security of symmetric key. SM2 encryption algorithm is used to encrypt symmetric key to ensure the security of main distribution. Check the data integrity for each transfer to see if the data has changed (Rodell et al. 2018). The cloud server stores private data in the cloud in the form of encrypted text, thus ensuring the security of storing private data to some extent.

Cloud computing platform angle Alibaba cloud ECS provides DDoS protection, cloud monitoring, and multiple real-time alarm functions. Therefore, the cloud platform selected is relatively safe. In short, the privacy protection system is designed based on hybrid encryption method, which combines the improved AES algorithm and SM2 algorithm to ensure the security of sending private data in the cloud environment (Sahour et al. 2020). Through experimental analysis and comparison, the

| Data size/MB | 16 | 32 | 64 | 128 | 256 | 512 |
|-------------|----|----|----|-----|-----|-----|
| Encryption/ms | 43 | 123 | 301 | 475 | 754 | 1347 |
| Decryption/ms | 36 | 104 | 287 | 447 | 712 | 1161 |

Table 4 Improved AES encryption and decryption time consuming

| Data size/MB | 16 | 32 | 64 | 128 | 256 | 512 |
|-------------|----|----|----|-----|-----|-----|
| SM3/ms      | 10 | 20 | 49 | 106 | 220 | 453 |
| SHA-256/ms  | 7  | 14 | 30 | 64  | 139 | 301 |

Table 5 Comparison of SM3 and SHA-256 generated summary
results show that the system not only improves the difficulty of the symmetric key, but also ensures the security of symmetric key distribution and improves the decryption speed of the system. Compared with other mixed encryption schemes, the scheme improves security and encryption, simplifies the decryption process, and has good practical effect.

Conclusion

Consistent with the genetic algorithm model, this paper investigates the onset time of the rainy season in northern China from 1970 to 2020 and finds that there is a long-term or short-term oscillation year by year at the beginning of the rainy season in northern China. The difference method is used to select the first and subsequent rainy seasons in northern China for analysis to study the appropriate circulation field and sea water temperature anomaly. In the 500 hPa mean circulation system, the second “northward jump” in the western subtropical Pacific is even earlier than that in the eastern Asian Pacific in summer. North China is located in the north of the rainfall belt. The circulation of the upper and middle layers cooperates with each other. The lower layer carries water vapor. The middle layer has water flow, and the upper layer flows. This provides an ideal flow field for the rainy season in northern China, leading to the first rainy season in northern China. Finally, this paper uses aliqucloud ECs to design a large information protection system based on cloud computing. When the user’s terminal and cloud server send big data, the system uses big data to encrypt private information. Test results show that it can effectively protect the security of private data and cloud computing transmission.

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Declarations

Conflict of interest The author declares that she has no competing interests.

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