Analysis of the Application of Artificial Intelligence in Computer Networks Technology

Changhua Chen*
Shanghai Open University Fengxian Branch, 201499
*Corresponding author e-mail: cch0586@126.com

Abstract: With the development of information technology and the continuous improvement of development level, artificial intelligence technology has also made better development. There are more and more application scenarios of artificial intelligence technology in computer networks, and it also plays a key role. Aiming at the shortcomings of traditional computer network routing methods such as slow iterative convergence and high resource occupancy, this paper proposes an artificial intelligence routing method based on optimized PSO. Based on the principle of the PSO algorithm, a mathematical model for optimal link optimization of a computer network is constructed, and local optimization is performed for the shortcomings of the classic PSO algorithm. The optimal path labelling function is given to the particles, and the optimal network is identified by continuously updating the current position and current speed. Link topology and travel path. Simulation results show that the proposed artificial intelligence method has faster iterative optimization speed, lower network delay, lower hardware resource occupancy under the same number of nodes and network structure, and can improve and improve the foundation of computer networks.

Keywords: AI, Ant colony optimization algorithm, PSO, Routing methods

1. Introduction

Computer networks use different forms of communication link relationships [1-2] to connect individual computer systems with independent functions to form a network structure to achieve rapid information transfer and resource sharing between nodes [3-4]. From the perspective of the user, connecting independent computer systems in different geographical spaces based on communication links can increase the total amount of data transmission and work efficiency of communication
equipment and meet the requirements of users' real-time communication. From the perspective of logical functions, Networking is one of the basic development requirements of the current digital age, and it is also the basic condition for long-distance barrier-free communication and exchange. Artificial intelligence technology is gradually developed on the basis of computer software and hardware and Internet technology [5], especially since the beginning of the new century, artificial intelligence has gradually become one of the main development directions of the computer industry [6], and in turn promote computer network technology Development and progress. Artificial intelligence technology simulates the behavior of the human body and human brain to achieve the purpose of autonomous control and learning of the computer system, and to improve the level of intelligent computing of the computer system and improve the efficiency of network data processing.

The application advantages of artificial intelligence technology in computer network systems are mainly reflected in the following aspects. First, artificial intelligence technology has strong data processing efficiency and learning and replication capabilities. Using existing network system information can improve the integration and processing of computer network data. Efficiency to meet the needs of different types of users; secondly, artificial intelligence technology can make relatively isolated computer network nodes closely connected, more intelligent [7], improve the ability of nodes to collaborate and share resources; the third artificial intelligence technology has powerful Rule inference performance can improve the coordination and management of network data with less network resources. In computer network management and system real-time communication, routing and link selection between nodes is one of the core technologies. Finding the optimal communication path between nodes [8] can not only save network resources, but also ensure more reliable network communication. For this reason, this article finds the optimal communication link in the computer network based on the PSO algorithm (particle swarm optimization algorithm) in artificial intelligence technology, and uses the ant colony optimization algorithm to optimize and improve the classic PSO algorithm to avoid searching for the communication link and improves the robustness of the computer network link.

2. PSO algorithm principle and establishment of computer network link mathematical model

In data transmission of computer network systems, network routing is one of the most critical links, that is, the process of data exchange and sharing is relatively simple, and the process of selecting the optimal path for data transmission is more complicated. In the data transmission, the host, the master and the slave must take a specific way to obtain the IP address of the other party, and send and receive data packets based on the network communication protocol [9-10]. When a computer network includes multiple IPs When the nodes are connected, the selection of the routing algorithm and the optimal communication path becomes very critical. Without a clear optimal communication path, the network router will not be able to effectively transmit data packets, which will not only reduce the power consumption of the network system and waste network resources. Or even data packet loss. The optimal routing communication path in a computer network refers to the shortest communication path between computer network nodes on the basis of effectively preventing link congestion. To find the most network path, you must first initialize the network system and tell the router how to find the next hop address. After receiving the instruction, the router implements data information grouping according to the packet size, and tries the next hop data based on the maximum capacity of the node. transmission. In a realistic computer network environment, the number of computer network nodes is
huge, and the process of selecting the optimal path is extremely complicated. However, artificial intelligence algorithms have more obvious computing advantages in the case of processing massive data and large samples. As an efficient artificial intelligence path optimization algorithm, PSO algorithm has the advantages of high efficiency, simple calculation and strong adaptability. The PSO algorithm treats path-optimized individuals as tiny particles, and gives the particles the initial position and speed. A large number of particles continuously learn the position and speed to find the best path, and continuously adjust the position and speed until they are identified. Out the best communication path.

According to the size and complexity of the computer network, a certain number of particles are dropped into the area. Let the total number of particles be regarded as a volume-free unit of motion in D-dimensional space. Current position and current speed:

\[
\begin{align*}
\vec{I}_i &= \{I_{i1}, I_{i2}, \ldots, I_{iD}\} \\
\vec{v}_i &= \{v_{i1}, v_{i2}, \ldots, v_{iD}\}
\end{align*}
\]

On the continuous iterative optimization process, each particle continuously finds its own optimal position and the optimal position of the entire group by adapting to the surrounding environment. All individuals in the particle swarm are constantly updated with the optimal target as the optimal target. Your own position and speed. The optimal path found in this process is the optimal path in the computer network system. The optimal position and speed model adjusted by the computer network system at the time can be expressed as:

\[
\begin{align*}
\vec{v}_i(t + 1) &= \omega \vec{v}_i(t) + \kappa_1 \tau_1 \left[ \vec{I}_{\text{best}}(t) - \vec{I}_i(t) \right] + \kappa_2 \tau_2 \left[ \vec{I}_{\text{bestall}}(t) - \vec{I}_i(t) \right] \\
\vec{I}_i(t + 1) &= \vec{I}_i(t) + \vec{v}_i(t + 1)
\end{align*}
\]

Among them, the inertia weight, and the value of the system cognitive coefficient in the optimization process are in the range, and the random number is in the range of the value.
3. Application of optimized PSO artificial intelligence algorithm in computer network routing

The classical PSO artificial intelligence algorithm has certain advantages in the selection of the optimal path of the computer network, but the classic PSO algorithm is liable to fall into local optimization during repeated iterations, especially when the computer network system is more complex, which can easily cause data congestion. If the network load continues to increase, the data throughput between nodes is uneven, and there is a greater risk of packet loss. If the local optimal solution is caught in iterative optimization, there is no guarantee that the selected computer network path is the optimal line. To solve the problem of computer network congestion, firstly, the travel path of the entire population of particle swarms can be planned in the early stage to reduce the introduction of too many data packets; secondly, control strategies are adopted to avoid falling into local optimization in the PSO algorithm and improve the efficiency of path optimization. This article uses the ant colony algorithm to optimize the classic PSO artificial intelligence algorithm, and gives the individual particles in the ant colony algorithm the characteristics of the individuals in the ant colony algorithm. The signature features are similar to the pheromone of the ant colony algorithm. Other individual particles can recognize the marks left by the previous particle, and make the optimal travel path method and the best speed judgment to avoid falling into the local optimum in the routing path optimization. Excellent solution, update the rule with the path mark indicating the first particle at time:

$$
\begin{align*}
\eta_i(t+1) & = (1-\rho)\eta_i(t) + \Delta \eta_i + \Delta \eta_i^* \\
\Delta \eta_i & = \sum_{i=1}^{n} \Delta \eta_i^*
\end{align*}
$$

Among them are the parameters of the model, which are the passage paths of the ranked particle swarm individuals. Only the marks left by the individual particle swarms within the rank can be recognized by other particles. With the expansion of the computer network and the increase in the
number of particles dropped, the phenomenon of network node data congestion can be better alleviated. An optimized travel path and reduce the risk of the system falling into a local optimum. After the optimized particle swarm processing, the number of markers left by the individual particles and the probability of the path selection are in the same direction. The probability of path selection can be expressed as:

\[ p_i^t (t) = 1 - \frac{\eta \cdot \gamma_i^t (t) w_i^\beta (t)}{\sum_{i=1}^{n} \gamma_i^t (t) w_i^\beta (t)} \quad (4) \]

Among them, the complexity of the labels left by the particles in the path optimization is the identification factor, and the importance and heuristic factors of the labels are respectively distinguished. In the process of accumulating the marked information, the same direction rule is adopted to prohibit repeated access to the same path and computer network nodes until the individual returns to the initialized position. Subsequent individuals in the particle swarm can exclude non-optimal paths based on the marks left by the previous individuals, simplifying the calculation process. The basic steps based on the optimized PSO routing algorithm are as follows:

1: Based on the classic PSO algorithm to initially plan the particle's travel path, determine the basic computer network link composition and topology, and delete redundant and dead network nodes.

2: Use the optimized PSO algorithm to adjust the initial value of the computer network and update the current position and velocity of the particles.

3: Set the maximum population of the particle swarm and the maximum number of iteration cycles, and give the particle individual information labeling function.

4: Determine the initial stage of local optimization of particle individuals, select more travel paths to obtain more diversified solutions. Among multiple routing paths, particle individuals will preferentially pass according to the most marked path, and the most marked ones. The link is the optimal path, and the path with a lower label assignment is gradually eliminated as the number of iterations increases.

The PSO algorithm optimized by the ant colony algorithm can not only continuously reduce the sample space of the communication path by continuously updating the current speed and position information of the particles, but also can use the path marks left by the particle during the process of traveling through the particle, Global optimization in the network space avoids the shortcomings of the classic PSO algorithm which is easy to fall into the local optimal solution and improves the efficiency and accuracy of optimal routing link optimization.

4. Experiment and simulation

4.1 Simulation environment settings

Simulate a real computer network scenario, and use Matlab simulation software to randomly generate a network topology structure diagram in an area of 1000m * 1000m. The simulated computer network
consists of 2 master nodes and 13 slave nodes (including 1 # node and 10 # node Master node), as shown in Figure 2 below

Figure 2. Simulation of computer network topology

The hardware system configuration of the master and slave nodes of the computer network in the simulation system is shown in Table 1 below. The software system of the test node uses the Windows 10 Professional Edition, and the computer programming language uses the Java universal version:

Table 1. Hardware structure of the test system

| Master node | Slave node |
|-------------|------------|
|             |            |
| CPU         | Intel core i9 3.6GHz,3 | CPU | Intel core i5 2.8GHz, 2 |
| RAM         | 16G        | RAM | 8G |
| ROM         | 1T         | ROM | 500G |
| Number of nodes | 2 | Number of nodes | 13 |

The other simulation parameter settings of the computer network are shown in Table 2:

Table 2. Simulation experiment parameter settings

| Experimental parameters | Parameter value |
|-------------------------|-----------------|
| Network bandwidth       | 100M            |
4.2 Network routing method performance verification

The verification paper proposes the practical application effect of the optimized PSO method in the selection of the optimal path of computer network routing. In order to make the comparison result more intuitive, the classic PSO method and the BP neural network method are introduced to compare. First observe the convergence speed of the method in the iterative optimization process, as shown in Figure 3 below:

![Figure 3](image-url)

**Figure 3.** Comparison of convergence speed of methods in link optimization

From the comparison of the convergence speed curves of each method in the optimization of the optimal path in Figure 3, it can be more intuitively observed that the proposed method has higher efficiency and convergence speed. In the initial stage, the convergence speed of the optimized PSO method decreases faster and is more efficient. The convergence has been completed when the number of iterations is 160 steps, while the traditional BP neural network method and classic PSO method do not complete convergence until 350 steps. Then observe the network delay changes of different methods when the optimal routing path is identified under the same hardware resources and network environment, as shown in the following figure:

| Parameter          | Value |
|--------------------|-------|
| Node delay         | 0-5ms |
| Network link delay | 0-10ms|
| Parameter value    | 1     |
| Parameter value    | 1.5   |
The comparison results show that, because the ant colony algorithm is used to locally optimize the classic PSO method, the proposed method can always maintain a low network delay and reduce the network delay in the process of computer network routing optimal path optimization. It is the basis for improving and improving the performance of computer network path optimization. Only on the basis of low network delay can the efficiency of optimal communication link identification be improved. Node network load and CPU resource usage are also important indicators to measure the performance of the method. If the CPU resource usage of a node is excessive, it will cause network congestion and reduce the performance of the computer network. It will shorten the path optimization time. The CPU resource usage of the master and slave nodes under different routing methods is shown in Table 3-5 below:

Table 3. Occupancy of node CPU resources in the simulated topology network structure (optimized PSO method, %)

| node category | Node number | CUP occupation | node category | Node number | CUP occupation |
|---------------|-------------|----------------|---------------|-------------|----------------|
| Master node   | 1           | 56.7           | Slave node    | 8           | 43.2           |
| Master node   | 10          | 61.4           | Slave node    | 9           | 45.1           |
| Slave node    | 2           | 35.6           | Slave node    | 11          | 46.7           |
| Slave node    | 3           | 52.4           | Slave node    | 12          | 46.7           |
| Slave node    | 4           | 44.6           | Slave node    | 13          | 38.9           |
Table 4. Occupancy of node CPU resources in the simulated topology network structure (classic PSO method, %)

| Node category | Node number | CPU occupation | Node category | Node number | CPU occupation |
|---------------|-------------|----------------|---------------|-------------|----------------|
| Slave node    | 5           | 47.8           | Slave node    | 14          | 48.5           |
| Slave node    | 6           | 49.2           | Slave node    | 15          | 52.6           |
| Slave node    | 7           | 51.2           |               |             |                |

Table 5. Occupancy of CPU resources of nodes in the simulated topology network structure (BP neural network method, %)

| Node category | Node number | CPU occupation | Node category | Node number | CPU occupation |
|---------------|-------------|----------------|---------------|-------------|----------------|
| Master node   | 1           | 68.7           | Slave node    | 8           | 54.7           |
| Master node   | 10          | 72.1           | Slave node    | 9           | 86.7           |
| Slave node    | 2           | 46.5           | Slave node    | 11          | 77.4           |
| Slave node    | 3           | 52.6           | Slave node    | 12          | 53.1           |
| Slave node    | 4           | 56.4           | Slave node    | 13          | 67.4           |
| Slave node    | 5           | 67.4           | Slave node    | 14          | 68.9           |
| Slave node    | 6           | 68.9           | Slave node    | 15          | 77.4           |
| Slave node    | 7           | 69.7           |               |             |                |
In the optimization of computer network path selection, as the network load increases, it will bring excessive load pressure on the node hardware, thereby reducing the system performance of the computer network. The statistics in Tables 3-5 above show that the use of ant colony algorithm to optimize the classic PSO algorithm, and the local optimization of the hardware system to distribute the load and power consumption pressure on the CPU, thereby improving the performance of the computer network.

5. Conclusion

With the development of computer network technology, the network topology becomes more and more complex, and the network link selection based on artificial intelligence method becomes more and more important. This paper proposes an optimized artificial intelligence network routing method based on the classic PSO method, which can effectively avoid the classic PSO method. The shortcomings and deficiencies in the local optimization process effectively reduce the occupation of network resources and improve the performance and robustness of computer network systems.

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