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Application of ant colony algorithm in web design

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Abstract: In recent years, with the continuous growth of people's demand for Internet information and the continuous expansion of Internet applications, web design has been paid more and more attention by people. However, in the actual design process, how to organically combine user needs, website characteristics and web content has become an urgent problem to be solved, and ant colony algorithm can provide help. This paper discusses the basic principle of ant colony algorithm and its characteristics in web design, and then puts forward the application method of ant colony algorithm in web design, aiming at giving full play to the function of the algorithm and improving the level of web design.

1. Introduction

Web design refers to the integration and planning of various information resources in the website, and the process of information transmission and management through computer technology. Its goal is to provide users with a friendly, efficient and practical interface. In recent years, the problem of web design has received widespread attention. As an intelligent computing method to simulate the behavior of biological groups, ant colony algorithm has the advantages of automaticity, mass generation, distribution, etc., and has great potential in solving complex problems. Therefore, it is necessary to study the application of ant colony algorithm in web design.

2. Basic principle of ant colony algorithm

The basic principle of the ant colony algorithm is that after the concentration of pheromones in an ant colony reaches a certain level, all ants will head in the same direction until they return to the original point. In practice, however, not all ants travel in the same direction, and some may change their direction to adapt to changes in the environment. Therefore, it is necessary to introduce a mechanism to determine whether ants change direction in the algorithm. Let n ants in the path length D, where there are m paths, m=1,2,... m (n). The number of ants on each path is L (L is the path length)[1-2].

The i th ant has a pheromone concentration corresponding to the i th node. For each path, randomly select several nodes in a certain proportion as the next path to be taken. When each node is selected as the next path to take, all ants on that node are given a pheromone concentration value as the probability that it will choose the next path. For a node, all the other points it passes between this node and another node are selected, and if an ant passes on this node, it has the chance to choose this path. If there are no ants on the node, it has no chance of choosing this path. For each node, its position can be represented by the following formula (1).

$$\begin{bmatrix} X_{ij} - X_i / X_j \\ Y_{ij} - Y_i / Y_j \\ Z_{ij} - Z_i / Z_j \end{bmatrix} \quad (1)$$

Where X, Y and Z are the points passed between node i and j; Xi is the point passed by all other points between the i th node and j; x_i, y_i and z_i are the points passing between the i th node and the j th point, respectively. Each step of the algorithm is based on the above formula to calculate the number of points passed by all ants on each path on the graph.[3]

3. Characteristics of ant colony algorithm in web design

3.1. Has parallelism

The "ant" in the ant colony algorithm is a kind of organism that can produce pheromones and has a strong clustering characteristic, which makes the ant colony algorithm work in a parallel way and can deal with large-scale problems. When ants search for food, they do not choose one ant at a time as their food source, but instead follow a route with a high concentration of pheromones at the same time. Ant colony algorithm is the same, in the search process, ants will always walk along the route with high pheromone concentration, rather than blindly random search[4-5].

3.2. Self-organization

Ant colony algorithm is a self-organizing algorithm whose purpose is to find an optimal path. In ant colony algorithm, the concentration of pheromone is an important factor to evaluate the performance of ant colony algorithm. When the ant colony algorithm runs to a certain stage, with the increase of pheromone concentration, an ant will move towards the optimal path due to the attraction of other ants around. However, at each node, due to the difference in pheromone concentration between individual ants, this concentration difference will produce an "attraction" effect, so that more ants with high pheromone concentration will appear in the entire ant colony, and these ants will also influence each other, so that the entire ant colony can move to a better path. A self-regulating and self-perfecting mechanism is formed in the whole ant colony system[6-7].

3.3. Positive feedback

Positive feedback means that the ant colony algorithm will continuously increase the pheromone concentration on the path with higher pheromone concentration and decrease the pheromone concentration on the path with lower pheromone concentration when searching for the optimal path. Therefore, if we can select the appropriate positive feedback function according to the characteristics of the problem, it will help to improve the optimization efficiency of ant colony algorithm[8-9].

The concrete manifestation of the positive feedback of the ant colony algorithm is that an ant will constantly transmit information to other ants in the process of finding a path, and ants with high pheromone concentration will transmit more pheromones to ants with low pheromone concentration, and so on. For a given problem, the pheromone values obtained by different ants can be used to determine the optimal path. At the same time, the ant colony algorithm can be combined with some other optimization algorithms to improve the optimization efficiency.

3.4. Good robustness

The pheromones in ant colony algorithm are greatly affected by the environment, and good robustness is one of the reasons why ant colony algorithm is superior to traditional algorithm. Ants behave according to certain rules, and in nature they are organized by groups called ant colonies. They bond by sharing pheromones, and in this way guide each other's behavior. In the ant colony algorithm, when the environment changes, the ants can make timely adjustments according to the new pheromone, which enables the ants to transmit and communicate information in a relatively stable and reliable way. In this way, when the environment changes, the ant colony algorithm will not fall into the local optimal solution or stop prematurely, but can find a new balance point in such changes, so that the algorithm maintains good robustness.

4. Application of ant colony algorithm in web design

4.1. Web layout planning

Web layout planning refers to the process of taking the website content as the core, taking the user's browsing experience as the goal, rationally organizing the content into the layout structure through the analysis and design of the website space, and carrying out information interaction and information sharing according to the user's browsing habits. At present, there are three layout planning modes in the process of web design: point-to-point layout, axisymmetric layout and multi-level layout. Based on the above three layout patterns, this paper takes three-layer layout as an example and analyzes its characteristics and constraints. Ant colony algorithm can be used to optimize it to achieve the optimal space division. The specific optimization methods are as follows: (1) In the layout model, grid nodes are used to organize data and establish links between nodes; (2) Divide different types of pages, analyze their structure and content, and extract elements that can represent the main body of the web page; (3) Analyze and process the extracted elements, integrate them into the page structure, and form a multi-level plane layout structure; (4) The ant colony algorithm is used to optimize the spatial layout and realize the optimization of webpage space division. According to this method, the content of the web page can be reasonably organized into the page structure, and through the ant colony algorithm optimization way to achieve multi-level space division, to meet the needs of users browsing while reducing the waste of website resources. This method can also divide the page space into multiple levels according to the needs of users to improve the efficiency of website management.

4.2. Comprehensive evaluation of multi-target web pages

A website presents a complete information in front of the user, but it can not simply compare this information with all other websites, because the web page itself is a whole, it also has a variety of attributes. For example, the structure and layout of a website can be divided into two aspects: navigation and content. Navigation refers to the directory structure of links in the page, while the content includes link information and text information. Different types of websites have different structures and layouts, which determines that they have different use values for users. Therefore, when evaluating a website, it is not only necessary to consider the navigation structure and layout of the website, but also to consider the content and information transmission function of the web page. This paper proposes a comprehensive evaluation method based on ant colony algorithm to evaluate a website.

Under the ant colony algorithm, when evaluating a website, it can be carried out in a weighted way, that is, within a certain range, for the same website, according to its own characteristics and

different needs of users, different weights are used. For example, for a portal website, the user group it faces is the vast number of netizens, so it should get more attention; For an educational website, the user groups it faces are students or teachers who are interested in education. In this example, the factors that can be used as evaluation weights are mainly shown in Table 1.

Table 1: Factors for evaluating weights

Name	Paraphrase
Web page quality	Comprehensive level of web design
Page design	Visual design and layout
Content and navigation	Guide function
Service and communication	Application-oriented function

4.3. Personalized Recommendation

Generally speaking, personalized recommendation is to obtain the potential needs of users through data mining and information retrieval technology, analyze and process the information based on these needs, and then find an optimal match in the known information. However, in practical applications, due to the lack of user behavior data and the limitation of computing resources, the recommendation system often faces the problem of cold start. At present, collaborative filtering is usually used for recommendation processing. However, the collaborative filtering method requires users to judge and calculate the similarity between items, and also needs to extract user characteristics to improve the accuracy of the algorithm.

The implementation method of personalized recommendation is as follows: Firstly, the user browsing behavior data is preprocessed, which includes three parts: commodity information extraction, user interest extraction and commodity feature extraction. Secondly, these three parts of data are used as the basic data set to build a personalized recommendation model based on ant colony algorithm. Detailed steps are shown in Table 2.

Table 2: Construction steps of personalized recommendation model

Step sequence	Controls
1	Commodity information is extracted by commodity information extraction module
2	Ant colony algorithm is used to process commodity information, including commodity ID, commodity name, commodity description and commodity category
3	Ant colony algorithm is used to process user interests, including commodity browsing behavior, behavioral preferences, and ratings
4	Calculate the matching degree of product information and user interests, generally > 70% can be recommended, and vice versa less or not recommended

5. Conclusion

In summary, ant colony algorithm can effectively improve the resource utilization rate of the website, improve the browsing speed and response speed of the website, so that the website can achieve the best user experience to a certain extent. However, there are still some defects in the application of the algorithm in web design, so it is necessary to further study the ant colony algorithm in the future, find better application methods and more perfect solutions, and get better application in web design.

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