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Mobile Guidance Model of Opportunity Network Node Based on Knowledge Graph

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Abstract: *When guiding the movement of network nodes, due to the lack of comprehensive analysis of node attributes, the success rate of network information delivery is low. Therefore, an opportunity network node movement guidance model based on Knowledge graph is proposed. The Knowledge graph of opportunity network nodes including degree centrality, proximity centrality, PageRank algorithm and Structural holes is constructed; When building the mobile guidance model of opportunity network nodes, the optimal solution of the Knowledge graph is taken as the result of node mobile guidance. In the test results, when the proportion of abnormal nodes in the test network is within 10.0%, the success rate of information delivery remains stable at over 0.90.*

Keywords: *Knowledge graph; Opportunity network nodes; Mobile guidance model; Optimal solution; Information delivery success rate*

1. Introduction

In order to maximize the transmission performance of the network, it is extremely necessary to move nodes reasonably [1]. Considering the composition of nodes in actual network environments, there are selfish nodes and malicious nodes. Among them, the biggest difference between the attribute characteristics of selfish nodes and normal nodes is that they refuse to forward data information from other nodes, but accept forwarding services provided by the network. The biggest difference between the attribute characteristics of malicious nodes and normal nodes is that they will randomly discard packets that need to be forwarded and send garbage packets to the network. The specific malicious nodes are mainly divided into three types: Black HoleAttack, Grey Hole Attack (randomly discarding packets that need to be forwarded), and flooding attack (sending garbage packets to the network environment). This is also one of the main factors affecting the success rate of network information delivery.

This paper designs a research on the node movement guidance model of opportunity network based on knowledge graph, aiming to use the information of knowledge graph to guide the node movement in opportunity network, so as to improve the efficiency and accuracy of nodes in the network.

2. Design of opportunity network node movement guidance model

2.1 Opportunity network node knowledge graph construction

Due to different transmission performance and attribute characteristics of different nodes in different network environments [2]. Therefore, from the perspective of ensuring the reliability of mobile guidance of opportunity network nodes, this paper first constructs the Knowledge graph of opportunity network nodes, as shown in Figure 1.

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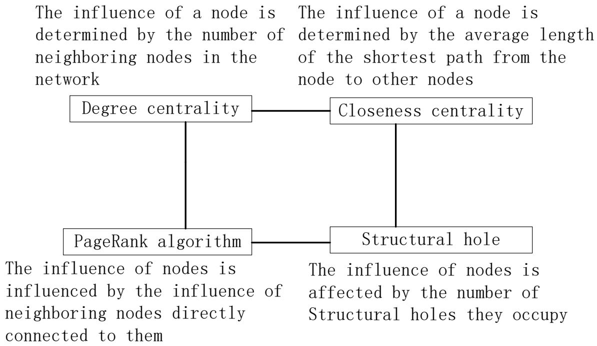

Figure 1: Knowledge graph of Opportunity Network Nodes

In combination with Figure 1, it can be seen that the node knowledge graph of opportunity network constructed in this paper mainly includes four aspects of node degree centrality, proximity centrality, PageRank algorithm and structural hole [3], so as to realize comprehensive analysis of node attributes and provide a reliable basis for subsequent node movement guidance.

2.2 Construction of mobile guidance model for opportunity network nodes

When building the mobile guidance model of the opportunity network node, this paper mainly takes the performance parameters in the Knowledge graph of the opportunity network node as the basis, and takes the corresponding position of the optimal node as the mobile guidance direction [4]. The specific model can be expressed as

$$f(i) = best(DC(i), CC(i), PR_i(t), SH(i)) \tag{1}$$

$$DC(i) = \frac{k_i}{n-1} \tag{2}$$

$$CC(i) = \frac{n}{\sum d_{ij}} \tag{3}$$

$$PR_i(t) = c\sum \frac{PR_j(t-1)}{k} + (1-c)\frac{1}{n} \tag{4}$$

$$SH(i) = \sum (\mu_{ij} + \sum \mu_{iq}\mu_{qj})^2 \tag{5}$$

Where, $f(i)$ represents the mobility guidance model of the opportunistic network node, $best$ represents the optimal function, $DC(i)$, $CC(i)$, $PR_i(t)$ and $SH(i)$ represent the degree centrality, proximity centrality, PageRank value of the current node position i and the grid constraint coefficient under the Structural holes respectively, k_i represents the degree of the current node position i, d_{ij} represents the short path length between the current node position i and the movable position j, and c represents the probability of the opportunistic node jumping randomly, n represents the total number of executable node movement positions in the network, μ_{ij} represents the ratio of the energy invested by the current node position i to maintain the relationship with the movable position j, and q represents the common neighbor between the current node position i and the movable position j.

According to the method shown above, the construction of the opportunity network node movement guidance model is realized.

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3. Application testing

3.1 Test environment settings

When analyzing The practical application effect of designing the opportunistic network node mobility guidance model, the specific experimental environment was built based on The ONE (opportunistic networking environment) open source simulation tool. In The ONE simulation, the node movement module is used to build a specific random walk mechanism and test the shortest path of node arrival in the network environment. The event and message generation module is used to set the generation rate of events and related messages in the test network environment. The specific route of the implementation model is constructed by the route setting module. Based on this, the parameters of the specific test environment built are shown in Table 1.

Table 1: Specific information settings for testing environment related parameters

Number	Test environment parameters	Set up
1	Scene size/m*m	2100*1250
2	Simulation duration/s	43250
3	Warm-up time/s	1200
4	Update cycle/s	0.10
5	Node transmission speed/kBps	300.0
6	Node communication range/m	30.0
7	Node cache space/M	12.5
8	Node waiting time/s	120.0(Maximum time)
9	Message size/K	1024(Maximum Message)
10	Message lifetime/s	3600

The construction of this test network environment is implemented in the manner shown in Table 1. On this basis, network node guidance method based on FOA-MCB and network node guidance method based on cloud computing are used as the control group to test the application performance of different methods respectively.

3.2 Test results and analysis

When analyzing the application performance of different methods, network connectivity was used as an evaluation indicator to test the corresponding success rates of information delivery in different abnormal node network environments. The test results are shown in Table 2.

Table 2: Comparison of test results of different methods

Proportion of abnormal nodes/%	FOA-MCB network node boot method	Cloud computing network node boot method	This paper designs a network node guidance method
0	0.9095	0.9135	0.9294
5.0	0.8927	0.9072	0.9203
10.0	0.8812	0.9010	0.9144
15.0	0.8703	0.8892	0.9065
20.0	0.8595	0.8685	0.9002
25.0	0.8507	0.8524	0.8933
30.0	0.8389	0.8346	0.8841
35.0	0.8310	0.8140	0.8757
40.0	0.8182	0.7856	0.8620

Based on the test results shown in Table 2, it can be seen that among the test results of three different opportunity network node mobility guidance methods, as the proportion of abnormal nodes in the test network continues to increase, the corresponding information delivery success rate shows a gradually decreasing trend, but there is a significant difference in the overall information delivery success rate. When the proportion of abnormal nodes in the test network is 0 (there are no abnormal nodes), the success rate of information delivery under the three network node guidance methods has reached over 0.90%.In the test results of FOA-MCB network node guidance method, the success rate of information delivery showed a steady decline with the increase of the proportion of abnormal nodes in the test network. When the proportion of abnormal nodes reached 40.0%, the corresponding success rate of information delivery decreased within 0.1 (compared with that when the proportion of abnormal nodes was 0). The specific information delivery success rate is 0.8182, reaching more than 0.80. In the test results of cloud computing network node guidance method, when the proportion of abnormal nodes in the test network is less than 10.0%, the success rate of information delivery is stable above 0.90, but when the proportion of abnormal nodes in the test network is more than 10.0%, the success rate of information delivery is significantly decreased, and when the proportion of abnormal nodes reaches 40.0%, the success rate of information delivery is less than 0.90. The corresponding information delivery success rate also dropped below 0.80. In contrast, in the test results of the network node guidance method designed in this article, when the proportion of abnormal nodes in the test network is within 20.0%, the success rate of information delivery is stable at over 0.90. When the proportion of abnormal nodes reaches 40.0%, the corresponding success rate of information delivery is also stable at over 0.86, with an overall decrease of only 0.0674.

4. Conclusion

In this study, firstly, the concepts of Knowledge graph and opportunity network and their applications in the real world are introduced. Then, by constructing a Knowledge graph, the relationship between nodes and useful knowledge are represented in the map. These relationships and knowledge can include semantic associations between nodes, attribute similarity, and so on. Based on this Knowledge graph, an algorithm is designed to evaluate the status of current nodes, identify potential opportunities, and select appropriate mobility strategies. The design model can guide the movement of nodes based on their characteristics and goals, ensuring network connectivity while maximizing the satisfaction of node needs.

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