

Research of Query-based Routing Algorithm on Peer-to-Peer Networks

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Abstract: We analyze a query-based routing method in P2P network (QRM). In this algorithm, the network nodes will be composed of multiple flood net. Each node maintains its own routing table, the node records and answer the received query. Simulation experiments demonstrate that the method can enhance the searching efficiency by increasing the number of queries.

Keywords: Semantic Similarity, Routing Table, Searching Method, LightFlood.

1 Introduction

P2P (Peer-to-Peer) technology is the research hotspot in recent years, it has become increasingly widely used in file sharing, search engines, distributed computing and other fields. Unlike the traditional C/S model. P2P network node is functionally equivalent, and both can act as the client can also act as a server role, nodes can establish a connection for direct communication with good self-organizing capacity and scalability. As the P2P network resources are distributed to each terminal node and lack of centralized control, its the core issue of how to efficiently locate resources in a P2P system.

First P2P network is a centralized index structure, like Napster, in the structure, all nodes index information is stored in a central server, all the queries are sent to the central server, it is easy to lead to single point failure problem. Followed by a fully distributed structure, the distribution is divided into and unstructured distribution networks. Structure networks (CAN [1], Chord [2], Pastry [3] and tapestry [4] as the example) mainly use distributed hash DHT algorithm to discovery and location resource, the main idea of DHT is that each node maps a value NodeID, node maintains a routing table according to the NodeID, maps a ID for query message with the same hash function and finds out the nearest node with the ID value, and then selectively forwards message following the routing table, thus can positions to the

required resources within a finite step. Unstructured network Gnutella [5] as the representative, it uses flooding algorithm for resource discovery and location, It is simple, but will bring lots of burden. In order to improve the resource discovery efficiency of unstructured P2P network, there have been many improved algorithms.

References [6], if the local node interested in a resource of another node. It is considered that the local node, the node may also be interested in other content of that node, so the local node to the node establish a shortcut, resources can be directory found through the shortcut.

References [7], extended References [6] method, proposed INGA method. It added a recommended node table to each node, Record those who initiated and from other nodes through the launch of its inquiry and the node information. So that shortcuts can be shared by other nodes. But in the routing table information rarely can only take the random walk method to find, search efficiency is not high, moreover, given the limited capacity of the routing table, it may store a large number of close nodes, the remote node many no storage space, can only take the flooding algorithm to find, which affects the efficiency of query.

References [8], proposed the query in two steps, first with a smaller step, the second step in the rings of a non-DHT query, more resources for those copies can be found through the basic first step, but for a copy of fewer non-

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popular files, by the second step than the blind flooding can greatly reduce the redundant message. Therefore, the algorithm can improve the query efficiency to some extent.

References [9], proposed LightFlood methods, Similar to [8], it also query in two steps, but the P2P network nodes are formed into a sub-tree (FloodNet), TTL value is small at first step, when the TTL = 0 these nodes as seeds, starting from the node into the second step query, the second step should be carried out in various FloodNet, greatly reducing the redundant information.

This paper based on the unstructured P2P network, assuming that the query is completely random, combining the advantages of references [7] and [9], proposed QRM method. In this method, the network nodes will be composed of multiple FloodNet, using LightFlood method, and at the same time, each node also maintains the routing table, preferentially storages remote node according to the results, because the storage space of each node is limited, impossible to establish direct contact with the node of interest to all. Simulation results show that the method can to some extent reduce the message redundancy, improve query success rate, The following detailed description of the algorithm.

2 Algorithm Description

2.1 Overview

First, some definitions:

Start node: the node that initiates the query.

Friend node: the node to meet the query.

Friend node list (topic, ID, hop): Friend node list stores friend node information on the theme of queries, topic stands for the query theme, ID for unique identifier of the node, and hop for query on the distance from the starting node to the current node .

Intermediate node table (topic, ID, hop): if the query launched from the starting node through a node, the information of the start node will be stored in the intermediary node table, the meaning of all properties in the table is the same as that in the friend node table.

In this method, each node maintains two routing tables: a friend node table and the intermediate node table, both tables give priority to store the remote nodes, the establishment of the routing table, see Section 2.3. The paper does not take into account influence of query frequency, assuming that query is completely random.

2.2 Semantic Similarity Calculation

To determine whether the contents of a node to meet the needs of a query, the node content and query theme will undergo a certain semantic similarity calculation, the query on start node can set a value of based on the actual situation, the node with similarity more than the value

will be regarded to meet the needs of the subject. For semantic similarity calculation, the vector space model VSM [10] will be applied. Using the model each query and each resource in node are represented by a vector. Suppose the node is based on the same conceptual set, the specific form of vector:

$$p = \{(C_1, w_1), (C_2, w_2), (C_3, w_3), \dots, (C_n, w_n)\} \quad (1)$$

C_i is a keyword in a query or resources, w_i is the weight of the key word in the query or the resources. Therefore, to compare the similarity of a query with documents, it only needs to compare the similarity of their vectors.

Suppose the vector of a query Q is expressed as:

$$p_1 = \{(C_{11}, w_{11}), (C_{12}, w_{12}), (C_{13}, w_{13}), \dots, (C_{1n}, w_{1n})\} \quad (2)$$

the vector of a resource R of node is expressed as:

$$p_2 = \{(C_{21}, w_{21}), (C_{22}, w_{22}), (C_{23}, w_{23}), \dots, (C_{2n}, w_{2n})\} \quad (3)$$

The method in References [11] will be used for calculating their similarity:

$$Sim(Q, R) = Sim(p_1, p_2) = \sum_{i=1}^{i \leq n} \sum_{j=1}^{j \leq n} [Sim(C_{1i}, C_{2j}) x (w_{1i}, w_{2j})] \quad (4)$$

$Sim(C_{1i}, C_{2j})$ means the similar method between any two concepts, to calculate its value with the method in References [12], the concept of the method according to content and structure is, called the concept tree, calculated as follows:

$$Sim(C_{1i}, C_{2j}) = \begin{cases} e^{\alpha l} \cdot \frac{e^{\beta h} - e^{-\beta h}}{e^{\beta h} + e^{-\beta h}} & \text{if } (C_{1i} \neq C_{2j}) \\ 1 & \text{if } (C_{1i} = C_{2j}) \end{cases} \quad (5)$$

means the similar method between any two concepts, to calculate its value with the method in References [12], the concept of the method according to content and structure is, called the concept tree, calculated as follows:

l is the minimum distance between the concept of C_{1i} and C_{2j} in the concept tree, h is the minimum depth of the two concepts in the concept tree, α and β are used to adjust the degree of influence of l and h on the similarity.

Similarity of recording topic property in the query and routing table is also handled the same way.

2.3 The Establishment of the Routing Table

According to the distance from start node to friend node, it is determined whether the node is added into the friend node table of the start node. When the friend node table is not full, all the friend nodes that has checked are directly put into the friend node table of the start node; if the friend node table is full, firstly calculate the distance from the starting node to the new found friend node (NewHop), and then find the record of smallest hop value in the

friend node table. If the hop value of the record is lower than NewHop, replace the record with this new friend node. If the records with the smallest hop value are multiple, then randomly choose one to be replaced. Otherwise, discard this new friend node. Each node in query process must update their intermediate node table. Record the theme of the query and the information on the starting node in the intermediate node table, the updating method is the same as the friend node table. After the query process is completed, if the record in the routing table used in this query can not return satisfactory results, delete it.

Continuously adjust the information on the friend node table and the intermediate nodes with the query process, thus shorten the distance among the nodes far away to improve query efficiency of network. The following specific description is how the two tables are continuously updated with the query process.

When a query on a particular topic passes a node, the node will record the TTL value of query messages at this time. Assume to record as RTTL, known as the node RTTL value of the node, while adding the starting node to the intermediate node table. If the intermediate node table is full, calculate the difference from the TTL initial value to RTTL value of query messages. The absolute value of the difference represents the distance from the starting node to the current node, then in accordance with the ideas described above to update the intermediate node table (that is, compare the distance with the minimum value of hop property in the intermediate node table. If the distance is more than the minimum value of hop property, replace the record with smallest hop property value with starting node of the query. Otherwise discard it.) If a node in the network meets the query topics, it will send the response message to the starting node. Response message should return following the path the query passes. The response message shall return TTL value, that is RTTL, of query messages recorded when receiving query message again. For the note received response message. First check whether the response note satisfies the query topic, if it does, the response node is regarded as his friend node, and then update his friend node table. The updating method is the same as above. The distance from the node to the note returning response message is equal to the absolute value of the difference from the RTTL value of the node to the RTTL of returning response messages.

2.4 Searching Method

First of all, according to LightFlood method, in the entire P2P space for the formation of a series of FloodNet, which is a logical structure. References [9] has detailed description on its formation process, which the structure of each FloodNet has been shown in Figure 1. When conducting query in FloodNet, each node will forward query messages to the node connected directly. For

instance, node E is directly connected to node B, H, I, the message from node E will be forwarded to node B, H, I. The query of the essay should be divided into 2 steps according to Lightflood.: Supposing a query from node A initiated the theme topic of the query Q, expressed as Q (topic, ID, FirstTTL, secondTTL), FirstTTL and secondTTL represent the first and second step length, respectively so that the TTL value of Q is the sum of the FirstTTL and secondTTL. Then conducting the first query: Node A Checks the local content to see whether it can meet the requirements, if not satisfied, and the message $TTL > 0$, then select K nodes and forward the message and minus 1 in FirstTTL at the same time. This choice of K nodes are based on the principles: first select a friend node table and query semantic similarity of nodes subject to a certain threshold, assuming that there is x a, if $x < K$, from the intermediary node, select the table that satisfies the query topic and add in, if y were assumed to find, if $(x + y) < K$, the underlying physical connection from randomly selected K-x-y were added in, if node A and node directly connected to the number of num $< (K - x - y)$, only select num one. The query process of receiving the message for each node should be treated the same as node A. If when FirstTTL = 0 and it didnt find the necessary nodes, then start the second processing step from the nodes in FirstTTL=0. This step is the same as basic as the first step, just each message transmitted by a secondTTL value of 1, and when forwarding message, if the friend node table and the intermediate node table dont meet the K of the query topic node, then, instead of selecting from the physical bottom connection as in the first step, selecting from FloodNet in these nodes, as shown in Figure 1, node B select from node A, D, E.

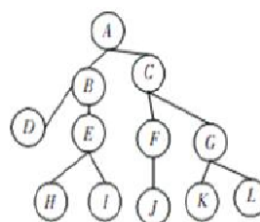


Fig. 1: FloodNet

3 Experiment and Analysis

In order to test the validity of QRM algorithm, and verified by Java simulation program, network topologies generated by using BRITE, generating a total of 8000 nodes for 10,000 queries, these queries are random, while assuming that each node in the node friend table can accommodate up to 500 records, intermediate node table

for up to 100 records, Query modeled LightFlood algorithm in two steps, taking the first step of the TTL value set <4 . Mainly compare Lightflood and INGA from the network traffic and query success rate, network traffic is the average number of message generated by per query. According to this method, when there is less queries, since each node in the node table and the intermediate nodes friend records in the table are very small that only LightFlood query algorithm should be adopted, network traffic and LighthFlood algorithm should be similar, with the development of inquiry, the contents of the routing table growing gradually, so many queries on the routing table can be found directly, many queries can locate to the necessary resources in one step, so network traffic will be greatly reduced. And Lightflood is relatively close to INGA algorithm, so with further increase of query, when the routing table capacity is full due mainly stored in the remote node, network traffic would be smaller than method via INGA. We can see it from the experimental results of figure 2.

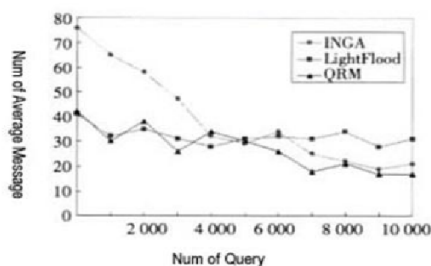


Fig. 2: Network Traffic

The query success rate shouldnt be calculated until inquiries stabilized. Because less information in the routing table when inquiries is less, and most inquiries can only be conducted via LightFlood flooding, which the query success rate is the same as LightFlood. As for LightFlood method, because it does not record any history of previous inquiries, or take any measures to guide to forward information to the node which would send satisfied results to, by which means blind flooding. In many cases, it requires a large step of time to find a satisfactory result, so less information in the routing table can not sufficiently reflect the advantages of this method. Therefore statistical query is up to 6000 after the success rate. As we can see from the results of experiment 3 that we can require a high successful rate even when the level of TTL is quite low. So this method, to some extent, lifts the rate.

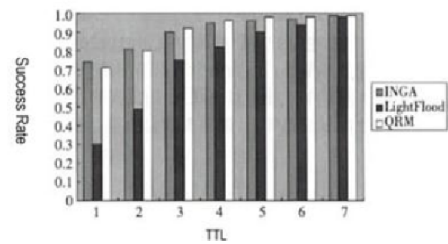


Fig. 3: Query Success Rate

4 Conclusion

This paper analyzed and discussed a Query-based Routing Method in P2P network, presents a method according to the distance of a node to query node to establish and maintain routing tables. Simulation results show that the algorithm has some advantages, the method can enhance the searching efficiency very well on the increase number of queries. In future work, we should take frequency of the impact into consideration to verify in the actual P2P network.

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