Improving Query Mechanisms for Unstructured Peer-to-peer Networks

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Outline

1. Introduction
2. Research Work
3. Simulation & Discussion
4. Conclusion & Future work

- What is resource query in P2P?
- Proposed Approaches & Existent Problems

What is resource query in P2P networks?

- **Resource query is one of the important issues of P2P networks.**
- **Structured P2P vs. unstructured P2P networks**
- **Three essential performance Criteria**
  - Recall
  - Search efficiency
  - Average path length

Existent Approaches

- **Search approaches of unstructured P2P networks can be categorized to blind search and informed search**
  - Blind search
    - Gnutella----flooding
    - Random walks----randomly select the next hop
  - Informed search
    - Directed BFS
    - Local indices

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- Problem Descriptions
- Algorithm Design

Problem Descriptions

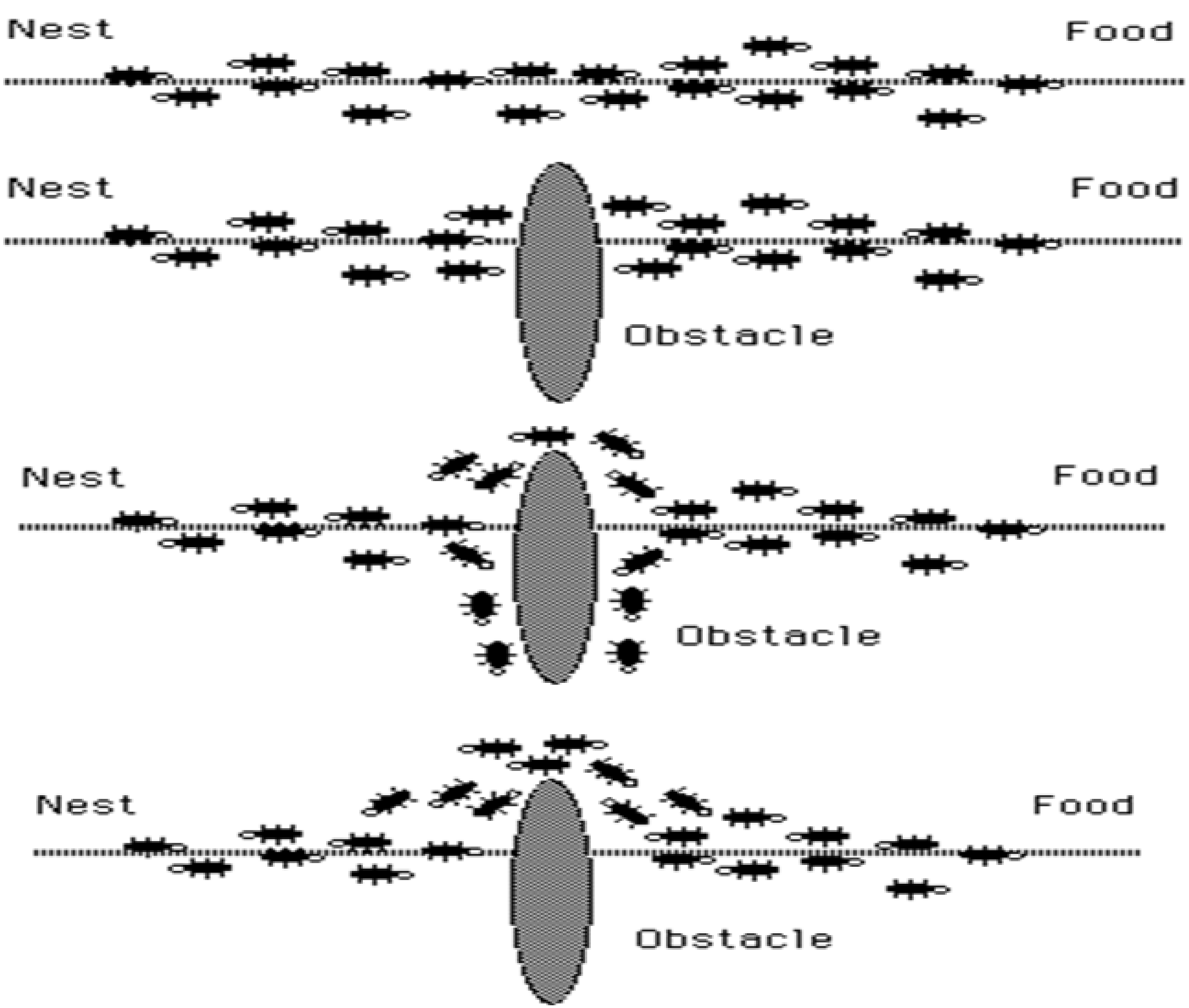
- An unstructured P2P network is defined as $G(V,E,R,C)$.
- V is a set of nodes denoting all peers in the network, i.e. $V=\{v_i \mid i=1,\ldots,n\}$. E is a set of edges which denotes all links in the network, i.e. $E=\{e_{ij}(v_i, v_j) \mid v_i, v_j \in V\}$. $R=\{r_i \mid i=1,\ldots,m\}$ is a resources set denoting all shared resources in G. C is a resource function $C:V\rightarrow P(R)$ that maps each node $v\in V$ to a subset of R, where $P(R)$ is a power set of R.

- **The problem is that given such G and $r' \in R$, how to solve V' subject to $V' = \{v \mid r' \in C(v) \cup v \in V\}$.**

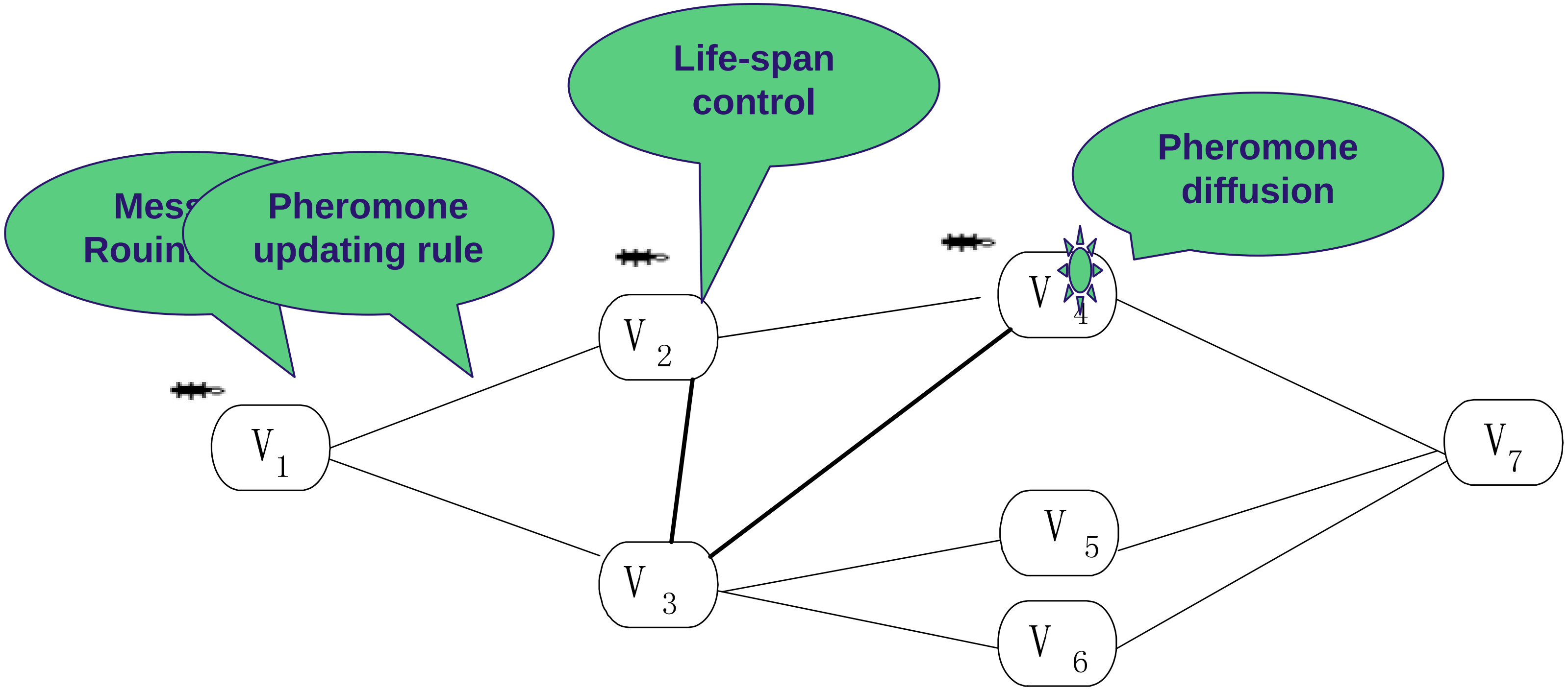
Algorithm Design

- Ant Colony System
- Ant-like Resource Query Algorithm

Ant Colony System



Ant-like Resource Query Algorithm



3 key rules

1. Message routing rule
2. Pheromone generation and updating
3. Life-span control

Message Routing Rule

- **The probability of artificial ant *k* selecting neighbor *j* at node *i* is defined as**

$$p_k(i,j)=\begin{cases}\dfrac{ph(i,j)}{\sum\limits_{u\in J(i)-Tabu(k)} ph(i,u)}, & j\in J(i)-Tabu(k)\\ 0, & j\notin J(i)-Tabu(k)\end{cases}$$

Pheromone generation and updating

- **In the following cases, pheromone will be generated and updated.**
  - 1) query messages will deposit pheromone on the path passed by

$$ph_i(n) = \alpha \cdot ph_i(n) + (1-\alpha)\Delta p_1$$

❖2) When having found a target resource at node n, the artificial ant would diffuse pheromone to all neighbors.

$$ph_m(n) = \beta \cdot ph_m(n) + (1-\beta)\Delta p_2, m \in J(n) \qquad (3)$$

❖3) For each entry of the pheromone table, an update will be done in period.

$$ph_i(n) = \rho \cdot ph_i(n) \qquad \rho \in (0,1)$$

- If a new node enters the P2P network, it will send update messages to all its neighbors. Update neighbors’ pheromone table by formula (3).
- If a new resource is stored in a node, it will send update messages to all its neighbors. Update neighbors’ pheromone table by formula (3).

Life-span Control

$$TTL(k) = \begin{cases} TTL(k) - 1, & r(k) \notin C(i) \\ TTL(k)\ , & r(k) \in C(i) \\ 0, & J(i) \subseteq Tabu(k) \end{cases}$$

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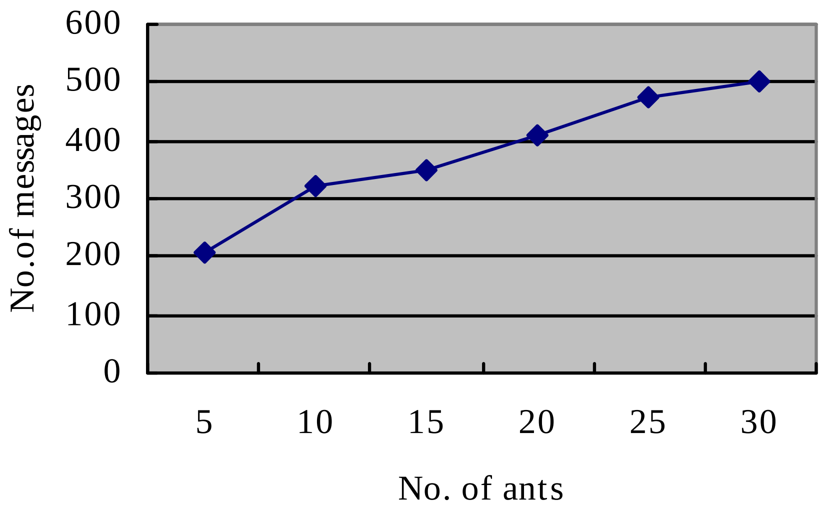
Simulation results and discussion

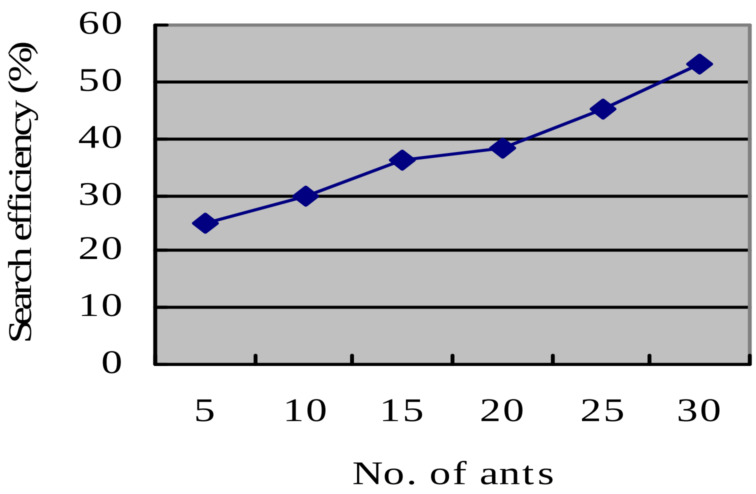
- NeuroGrid simulator is a Java based P2P network simulator which emphasizes particularly on simulation and performance test for unstructured P2P network.

Table 1. Parameters in simulation

Configuration parameters	Value
No. of nodes	1000
No. of documents	1000
No. of keys	100
No. of neighbors at each node	4
No. of keys at each document	2
No. of documents at each node	4
Initial TTL	7

Relation between the number of ants and algorithm performance





These figures show that with the number of ants increasing, search efficiency will properly increase, but the number of messages will increase simultaneously.

Comparisons of four algorithms

Criteria	Our algorithm	NeuroGrid	Gnutella	Random Walks
Ave. path length	5.3	4.6	63	9.2
No. of messages	320	154	5400	2650

The performance of our algorithm is acceptable .

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Conclusion

- An ant-like query message routing mechanism is suggested.
- By adjusting the number of ants, a better tradeoff between search efficiency and cost could be achieved.
- The maintenance cost of a pheromone table is low, which hardly increase the burden of the resident node.

Future work

- **Improving our algorithm and further performance analysis**
  - update policy of pheromone
  - Relationship between the number of ants and the size of a network
  - Adaptability while nodes entering and leaving frequently.


Thank You !