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A QoS Routing Algorithm Based on Ant Colony Optimization and Mobile Agent

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Abstract

The current Internet can only provide "best effort" transport service, so it is becoming a very urgent task how to provide QoS guarantees for growing video on demand, multimedia conferencing and other multimedia applications based on the existing network architecture. This paper proposes a QoS routing algorithm based on mobile agent and ant colony (*QR2A*). The *QR2A* algorithm combines various constraints and network load conditions with the ant colony algorithm in the pheromone, while not only meets the QoS requirements, and solve the problem of network load balancing effectively, and the algorithm is less cost. Meanwhile, the paper also gives formal description, correctness and convergence analysis of *QR2A* algorithm. Finally practical effect of the algorithm is verified through by the simulation experiment.

*Keywords:*QoS, Routing algorithm, Ant Colony Optimization,Agent;

1. Introduction

The current Internet can only provide "best effort" transport service, so it is becoming a very urgent task how to provide QoS guarantees for growing video on demand, multimedia conferencing and other multimedia applications based on the existing network architecture[1-3]. This paper presents a QoS routing algorithm based on mobile agent and ant colony (QR2A). The QR2A algorithm combines various constraints and network load conditions with the ant colony algorithm in the pheromone, while not only meets the QoS requirements, and solve the problem of network load balancing effectively, and the

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algorithm is less cost. Meanwhile, the paper also gives formal description, correctness and convergence analysis of QR2A algorithm. Finally practical effect of the algorithm is verified through by the simulation experiment.

2. Routing mechanisms in the QR2A algorithm

1) State transition rules

According to pheromone and cost of the links, calculate probability selected value in the node routing table. As $j \in J_k(i)$, the probability that the ants select the path (i, j) is defined as following.

$$p_{ij}^k = \begin{cases} \dfrac{\alpha \cdot \tau_{ij} + (1-\alpha)\xi_{ij}}{\sum_{l \in L(i)} [\alpha \cdot \tau_{il} + (1-\alpha)\xi_{il}]}, & j \in L(i) \\ 0, & j \notin L(i) \end{cases} \quad (1)$$

Where $J_{k(i)}$ denotes the set that the k ant can choose in the next step. $p_{ij}^k(t)$ $J_k(i)$ denotes the probability that the ants select the path *(i, j)*, $\tau_{ij}(t)$ denotes the pheromone concentration of path *(i, j)* at time t, $\eta_{ij} = 1 / C_{ij}$, C_{ij} denotes the cost of the path *(i, j)*, α 和 β the parameter α and β are used to control the importance of the pheromone and the path length[4,5].

2) Refresh rules of the local pheromone

When the ant (agent) forward each a link, refresh the link pheromone concentration on the rule, if the links meet the QoS constraints, the concentration of pheromone is increased , or pheromones are volatile state, reduce the probability that link is selected by ants later. The rule as following

$$\tau_{ij} \leftarrow (1-\rho_1)\tau_{ij} + \Delta\tau_{ij}^k + \varpi_k \quad (2)$$

3) Global pheromone refresh rules

when a ant find a path to meet the QoS constraints and return to the source node successfully, the rule will be used to refresh the pheromone concentrations of the entire path. If overall routing costs of the ant is low, then the pheromone concentration increase of the path of will be greater. The rule as following.

$$\tau_{s,d} \leftarrow (1-\rho_2)\tau_{s,d} + \frac{\Delta\tau_{s,d}^k}{C_{s,d}} \quad (3)$$

3. The specific process of the QR2A algorithm

If there is a connection request, source node is *s*, destination node is *d*, where B_w is the minimum bandwidth requirement for R, D_w is the delay requirement for R. The agent must meet the following conditions in the process to explore the path P (*N* is the set of passing nodes).

$$Delay\ (P) = \sum_{l \in P} LD_l + \sum_{n \in N} ND_n \le D_w \quad (4)$$

$$Bandwidth(P) = \min_{l \in P}\{LB_l\} \ge B_w \quad (5)$$

Given that each node in the system performs the same routing algorithm. When a source node *s* receives a connection request from the destination point *d* with parameters $R(B_w, D_w)$, firstly initialize the pheromone table adjphertable[*] and publicphertable[*] of the network each node with initialization pheromone value. To further improve the speed of the algorithm, the nodes that do not meet the bandwidth constraints of all links are cut off before applying ant colony algorithm at each node, and then the *QR2A* algorithm will achieve as following steps.