Automation of social networks with QA agents (Extended Abstract)

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ABSTRACT
This paper describes a model, ASKNEXT, for connecting agents using social networks for knowledge exchanges using email. It proposes a protocol and a mathematical model to understand how emails spread throughout social networks of agents and people, which can be used to predict the scalability of agents exchanging emails to find answers to questions.

Categories and Subject Descriptors
I.2.8 [**Problem Solving, Control Methods, and Search**]

I.2.11 [**Distributed Artificial Intelligence**]

K.4.3 [**Organizational Impacts: Computer-supported collaborative work**]

General Terms
Algorithms, Design.

Keywords
Agents, QA, email, trust, knowledge exchanges, social networks.

1. INTRODUCTION
This paper states that a possible killer application of agents is to participate on behalf of users in knowledge exchanges [1] where the users themselves are the best equipped to understand each others' questions and problems and to give appropriate answers [2]. There have been many attempts to create webs of knowledge exchanges [3], but there has been almost no work on multiagent systems to answer questions, with the exception of [1].

Combining agents with people to answer questions is a promising approach in which people can contribute answers with their imaginative skills, and agents can crawl through their answers to find the most relevant ones. Even better, the agents can answer questions on behalf of the contributors. This would be a seamless change of paradigm, where people would train their agents to answer on their behalf instead of simply linking and spamming knowledge and information as they do today. We call this process collective search, where a group of agents and people will collectively compose answers.

This paper contains a proposal for a collective search in which agents help users to automate the process of answering questions through a social network using e-mail as a communication system.

In addition, a protocol, ASKNEXT, is proposed, where agents with a contact list [4] automate question answering in the social network by asking their friends, who in turn could send forward the question to their own friends. In a future paper, we will explore the application of the FOAF (Friends of a Friend) ontology in our protocol.

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2. TYPESET TEXT ASKNEXT: A PROTOCOL FOR FINDING ANSWERS IN A COLLECTIVE WAY
Every user has at least one agent that feeds off the user's knowledge. The agent will help the user in spreading his knowledge and in acquiring new knowledge. Each agent will need a contact list (as its user has). In our protocol, we use email communication because of its asynchronous features. Necessary improvements like search for expertise are topics for future work. Thus, ASKNEXT is based on the connections among agents using social networks, described as the interconnection of the contact lists of each agent or person, and ranked by degrees of trust. A set of equations are presented to describe the behavior of this protocol.

2.1 Text Protocol and Properties
ASKNEXT consists of the following protocol:

- When an agent has a question (it is a questioner):
    - The agent asks the question to its Agent Contacts (AC) and waits for an answer.
    - If it does not receive an answer before a given deadline, it asks its Human Contacts (HC).
    - If after a second deadline there is no answer, it asks its AC to ask their HC.
    - When some contact (agent or human) answers, it notifies all others to stop searching.
    - In the case there still is no solution, the agent will insist on asking the humans in its HC.
- When an agent receives a question from another agent (it is an answerer):
    - The agent checks that it has not received the same question before (from the same owner with an identical time stamp). If the question was received before, the agent ignores it.

- If the agent knows the answer, it answers the agent that asked it.
- Otherwise, the agent forwards the question to those agents in its AC that it thinks have not already received the question.

- When an answerer receives an answer, then it passes the answer to the next agent in the answering thread.

The question thread is defined as the sequence of agents that ask each other the question, and the answering thread as the reverse sequence of agents that answer the question or return the answer that another agent has found, with or without further processing.

The deadlines are necessary to make sure that agents are only asking humans when the agents cannot answer the question.

To stop a search, the speed of sending an answer must be higher than the speed of asking. Eq. 1, that has to be discretized to obtain adequate results, indicates the time needed to stop a search through an infinite network, where

- t_s is the time required to stop the search.
- r is the distance in the contact network (AC and HC) from the origin of the question to the nearest agent that knows the answer.
- v_R and v_F are the rates of answering and forwarding questions, measured in e/s (emails/second).

$$t_s = \frac{2r}{v_R - v_F} \quad (1)$$

Eq. 2 gives us the relation between speeds v_R and v_F that assures that when a search ends it reaches the next level in the contact hierarchy; Eq. 3 tells us the time needed to receive an answer (t_A) as a function of r.

$$r \leq \frac{v_R}{2v_F} \quad (2)$$

$$t_A = \left(\frac{r}{v_R}\right) + \left(\frac{r-1}{v_F}\right) \quad (3)$$

2.2 Protocol Test

To test this model and protocol, a prototype is implemented, and some simulations are performed and compared under the following assumptions:

- Every agent has the same amount of contacts;
- Only agents answer;
- The first received answer is adopted as the correct one.
- The amount of agents A_r at a distance r from the questioner $A(r > 0)$ is described by Eq. 4, where N is the number of contacts that each agent has, and the total number of agents is described by Eq. 5.

The following case was tested: all agents have a contact list size of 3; there are 3 levels of depth; the value of v_R is 1/10 e/s; the values of v_F are 1/10, 1/30 and 1/120 *e/s*; the distances r are 1, 2 and 3.

$$A_r = N\,(N-1)^{r-1} \quad (4)$$

$$NA_r = 1 + \sum_{i=1}^{r} A_i \quad (5)$$

3. COMPARED RESULTS AND CONCLUSIONS

Table 1 shows the results of the test, in which there is little deviation from the real prototype, mainly due to the delay of checking the email box. We therefore claim that the equations are sound because they reflect the behavior of the simulations and the real prototype.

Thus, with our model it is possible to predict the time it takes for an agent-run search to find an answer, given that the answer is expected to be found at some fixed distance.

Table 1. Test of the ASKNET model "t_A eq.", its discrete simulation "$t_A$sim." and a prototype "t_A p."

r	v_F	t_A p.	t_A sim.	t_A eq.	t_s p.	t_s sim.	t_s eq.
1	1/10	20	20	20	51	50	50
2	1/10	50	40	40	80	70	70
3	1/10	80	60	60	110	90	90
1	1/120	20	20	20	30	30	30
2	1/120	163	150	150	180	170	170
3	1/120	300	280	280	330	310	310
1	1/30	20	20	20	30	30	30
2	1/30	70	60	60	100	80	80
3	1/30	120	100	100	150	130	130

Regarding the scalability of the questioner, we can see that the maximum number of answers it can receive is the size of its contact list and is the logarithm of the number of entities that receive the question.

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5. REFERENCES

[1] Boris Galitsky and Rajesh Pampapathi, Can Many Agents Answer Questions Better than One? *FirstMonday*, volume 10, number 1 (January 2005)

[2] Sanjay Gosain Mobilizing software expertise in personal knowledge exchanges, *The Journal of Strategic Information Systems*, Volume 16, Issue 3, September 2007, pp: 254-277

[3] Liljenback ME., ContextQA: Experiments in Interactive Restricted-Domain Question Answering, MSc. in CS Thesis, San Diego University, 2007

[4] O. Shelhory. A scalable agent location mechanism. In N. R. Jennings and Y. Lespérance, editors, ATAL, volume 1757 of *Lecture Notes in Computer Science*, pages 162–172. Springer, 2000.