

Towards nature-inspired communication in Peer-to-Peer networks

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Abstract

After having first been used as a mean to publish content, the Web is now widely used as a social tool for sharing information. It is an easy task to subscribe to a social network, join on of the Web-based communities according to some personal interests and start to share content with all the people who did the same. Easy once you solved two basic problems : select the network to join (go to hi5, facebook, myspace, ... ? join all of them ?) and find/pick up the right communities (*i.e.* find a precise label to match non-precise centers of interest). An error of appreciation would result in getting too much of useless/non-relevant information. But would it be possible to design an effort-less way of sharing information on the web ? Ideally, such a solution would not require the definition of a profile nor a selection of communities to join. Publishing information should also not being the result of an active decision but being performed in an automatic way.

This short paper is a summary of a book chapter[7] in which the problem and a possible solution based on a nature-inspired communication scheme are both described.

1 Network communication schemes

The generic setup for a communication scenario consists in a the definition of a channel between a sender and a receiver. The transmission of the message takes place over this channel, from the sender to the receiver. However, all scenarios are not equivalent and can be discriminated according to different characteristics such as the number of receivers or the periodicity of exchanges. An important characteristic is the initiator of the transmission: a server may decide to send (“*Push*”) the message or a receiver may ask (“*Pull*”) for it. The difference as an essential role for the receiver and the dynamics of communications.

Pushing messages appears to provide many advantages for both servers and receivers[4]. Messages can be received even without being explicitly requested. Receivers do not need to reveal their identity to the servers and, in turn, the servers are free from keeping track of a large list of clients. Moreover, communication channels does not need to be explicitly established and can be replaced by a common communication bus used to post and get messages[1]. The success of microblogging sites such as twitter shows the interest for people in pushing atomic pieces of information over such a communication bus.

2 Nature-inspired pushing of information

Nature inspired computing paradigms provide the robustness and flexibility typically needed in the context of complex systems such as communication between peers. Several communication schemes based on the pushing of a message to one or several receivers have been designed. In particular:

- In **epidemic systems** a sender is an individual affected by a disease (the message to send). Once a receiver receives the message, it become in turn a potential sender able to infect other individuals. This mechanism, first used to maintain updates in distributed databases[2] is now commonly know as a “Gossip” protocol. An important design part of Gossip algorithms is the transfer of state from the sender to the receiver.

- The **stygmergic communication** model used by ants[3] illustrate a message pushing-scheme based on alteration of the environment. By laying down pheromones (messages to send) on the soil, an ant leaves a message readable by every other ant passing by.
- Finally, the rivalry between antigens and antibodies as seen in **immune systems** shows a way to track specific receivers. Antibodies in charge of chasing and destroying antigens can be mapped to sender chasing potential receivers. Messages are embodied into antibodies which walk through the network and undergo proliferation when the environment is favorable for it, aging prevent them from saturating the system[5].

In[8, 6], we investigated the use of nature-inspired dissemination of information for the design of new communication schemes for web communities. An algorithm combining epidemic systems and artificial ants as been proposed as a proof of concept.

3 Achieving network-level stigmergy

Twitter is a both a model of gossiping (by re-tweeting some tweets) and a stygmergic communication place (twitter website). Editing a web 2.0 website such as Wikipedia is a stygmergic process involving every website reader and contributor. But those stigmergic process currently limited to some specific places (*e.g.* Wikipedia, Twitter, ...) and are, thus, application dependent. Moreover, sharing messages over those systems is an active process that a sender/receiver must undergo.

Being able to achieve a similar stygmergic process on a lower level would provide a new application independent communication scheme and provide a selective dissemination layer separated from the application layer. In[8, 6] the metaphors used to design communication algorithms is that of a group of people talking in an open space. In this context, the underlying communication channel allows for any individual to hear what others are saying - providing they are not too far away. All the persons are also free to move around the space. Typically, those moves would be targeted towards three objectives : get closer an acquaintance, reach the source of an interesting discussion or just walk randomly, hoping to stumble upon some interesting conversations. As people are moving and talking, interest based clusters are emerging from the initial, unstructured, crowd.

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