Evaluating the Dynamic Behaviour of *PROSA* P2P Network

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Abstract. In this paper we present and simulate a new self–organising algorithm for P2P unstructured networks inspired by human relationships. This algorithm, called ***PROSA*** , tries to simulate the evolution of human relationships from simple acquaintance to friendship and partnership. Our target is to obtain a self–reconfiguring P2P system which possesses some of the desirable features of social communities. The most useful property of many natural social communities is that of beeing "small–worlds", since in a small–world network queries usually require a small amount of "hops" to walk from a source to a destination peer. We show that ***PROSA*** naturally evolves into a small–world network, with an high clustering coefficient and a relly short average path length.

1 Introduction

The way social contacts and relationships are arranged, how they evolve and how they end, is matter for psychologists and social scientists research. Nevertheless some studies about social groups and their connections reveal that a "social network", i.e. the network of relationships among people from simple acquaintance to friendship, has many interesting properties that can be exploied in a real–world P2P structure.

The Milgram experiment of 1966 [6] showed that a message from a "source" to a "destination" person can be delivered by forwarding it step–by–step to just one of the related people, in the direction of the destination. In practise Milgram asked to sixty people located in Kansas to send a letter to a specified person located in Cambridge. The participants could just pass the letter to personal acquaintances, hand–by–hand. About one quarter of the total number of letters were delivered to the destination person, and Milgram found that the mean number of "hops", i.e. the number of persons involved in each delivery, was about six. This experiment opened the research in the field of "small–world" networks [9].

The small–world property seems to be a characteristic of many human communities, such as mathematicians, actors, scientists. A small–world arises almost naturally whenever social contacts among people are involved: many researchers are trying to understand the reasons of this behaviour. In this work we're not interested in answering this question. Our target is just to develop a P2P system using rules and concepts inspired by human behaviours and relationships dynamics.

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In a social network there are several kind of social links among people. We can identify "acquaintance–links" and "semantic–links": the former expresses a simple "acquantaince" among people; the latter requires at least an acquaintance–link plus some additional information about interests, culture, abilities, knowledge etc. In our life semantic–links arise almost naturally. You need no great effort to establish a semantic–link with somebody: you have just to share a knowledge field or a passion or simply an interest with a person and meet him in some circumstances, have a talk with him and no more. Once you know somebody shares a certain knowledge or passion with you, a semantic–link in that field with that person is established and you're ready to use that link the next time you need information, help, assistance or collaboration in that field.

In real life we massively use semantic–links to speed up information retrieval. For example if a car vendor wants information about Linux, he asks his nephew, who is studying Computer Science at University, but doesn't ask his wife since she is a biologist and she does not like computers. Note that both of them (this nephew and his wife) are "semantic–links", but they belong to two different semantic fields. His nephew, who doesn't know anything about Linux, will ask to one of his colleagues of the Operating Systems course, who is famous as being a Linux guru and can give him the required information: using semantic–links a car vendor reaches a Linux guru in just two hops. If the car vendor in our example doesn't have a nephew studying Computer Science, he asks to a friend (acquaintance–link) at random, hoping somebody knows what Linux is. Our daily experience says that, at the end, he will find somebody who can help him gathering information about Linux.

The same mechanism that allowed Milgram's letter to be correctly delivered from Kansas to Cambridge in just six hops is exploited in the given example: small–world characteristic of a network allows efficient information retrieval. This is how small–world networks work.

In this paper we introduce a P2P structure, named ***PROSA*** [2], in which semantic proximity of resources is mapped onto topological proximity of peers. ***PROSA*** is inspired by social relationships and their dynamics, since social networks characteristics can be exploited to optimise query forwarding and answering. ***PROSA*** uses a self–organising algorithm that dinamically links peers sharing similar knowledge and resources, putting them into high clustered and self–structured "semantic groups". To validate the proposed algorithm we developed a functional simulator and we used it to show that ***PROSA*** really evolves into a small–world network.

The paper is organised as follows: Section 2 is a short survey about current work in the field of P2P resource retrieval; in Section 3 we discuss our proposal; in Section4 we show simulation results and finally Section 5 presents a plan for future work.

2 Related Work

In the last years the interest on overlay networks has increased, mainly because bandwidth, computing power and cheapness of personal computers allow to implement such kind of "logic" networks. Examples of overlay networks include Gnutella, Freenet [3], CAN [5], Tapestry [10]. Each of them focuses on a particular aspect of P2P computing: Gnutella is totally unstructured, Freenet is practically anonymous, CAN is search–efficient and so on.