Study of Internet model and its properties for efficient routing algorithms

David Coudert
david.coudert@sophia.inria.fr
http://www-sop.inria.fr/members/David.Coudert/

Nicolas Nisse
nicolas.nisse@sophia.inria.fr
http://www-sop.inria.fr/members/Nicolas.Nisse/

Assume a message must be sent from a source to a destination node in a network. At each step of the route, one must decide the next hop the message will follow to eventually arrive at its destination. This problem is known as the routing problem. If the whole map of the network is known, the problem is easy to solve : using the Dijkstra algortihm, the message can reach its destination via a shortest path. However, the topology of many networks (e.g., Internet) are unknown because of their size or dynamicity. In this setting, many "simple" algorithmic problems become challenging because they must be delt with using only local views of the networks, i.e., without having a full knowledge of the topology. For instance, the routing problem ask the difficult question of the tradeoff between the knowledge of each node about the topology of the network it belongs to, and the performances of the routing algorithm (generally measured as the ratio between the length of the route actually computed and the length of a shortest route). See [Gavoille07] and [Gavoille09] for overviews.

Localized algorithms are a way to takkle algorithmic problems when the topology of the network is not globally known. However, in many cases, lower bounds on the performances of algorithms in this context are far from those expected. One possible issue is to consider particular graph classes and take advantage of particular structural properties of these graphs [AGGM06,NSR09,Thorup04]. For instance, in the routing problem, efficient algorithms (i.e., using logarithmic memory, and producing shortest paths) are known in the class of trees [FrGa01,ThZw01], while such performances are known to be impossible in general.

The goal of this internship is first, the study of various strutural properties of internet like topologies that may help to the design of Internet routing algorithms. Promissing properties are expansion, length of induced cycles (chordality), average number of shortest paths, hyperbolicity, and community structure. A second part of the intership will be the design and implementation of an internet based topology generator, fulfilling as close as possible the previous studying properties.

Main objectives of the internship:

- Identify structural properties of graphs that are interesting in an algorithmic point of view. Again, we will focus mainly on problems related to Internet routing.
- Design exact or approximate / randomize or deterministic algorithms for 1) deciding whether a graph satisfies some (or combinaison) of the properties pointed out in the first phase, and 2) generating Internet like graphs satisfying these properties.

Required background: Algorithmic, graph theory, optimization, distributed algorithmic

Duration: 4 to 6 months with possible continuation in PhD

Project team Mascotte, INRIA, I3S, CNRS, University of Nice Sophia
2004, route des Lucioles – B.P. 93 – F-06902 Sophia Antipolis Cedex – France

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Project team Mascotte, INRIA, I3S, CNRS, University of Nice Sophia
2004, route des Lucioles – B.P. 93 – F-06902 Sophia Antipolis Cedex – France