Test and Generation of Graphs satisfying Specific Structural Properties

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Nowadays, designing efficient algorithms for Internet-like networks - or large scale networks - becomes an important task. Due to the size of these networks, tackkling simple algorithmic problems - for which polynomial-time algorithms are known - become challenging. One promising approach consists in taking into account the specific structural properties of these networks in the design of algorithms. For instance, large scale networks are known to have "small" diameter (logarithmic in their size), power law degree distribution and high clustering coefficient (roughly, two nodes with a common neighbor are neighbor with high probability). A good knowledge of the structure of the considered networks helped to design theoretically efficient algorithms to solve many problems.

However, this theoretical work must now be validated by simulations. In particular, such simulations may help to study further the behaviour of the algorithms in order to point out their drawbacks, weak points and to improve them. In order to perform fair simulations, we need to be able to generate graphs with properties similar as the ones of large scale networks. Therefore, the next step consists of the design of generators of graphs satisfying various structural properties so as the design of algorithms for checking that a graph actually has the desired property.

The goal of this project is the study of various structural properties of graphs that may help to the design of algorithms. Promising properties are expansion, length of induced cycles (chordality), average number of shortest paths, hyperbolicity, and community structure. On one hand, we will focus on algorithms for testing whether a graph satisfies or not a given property. On the other hand, we will also consider algorithms to generate such graphs.

Main objectives of the PFE:

- The first goal of this project is to provide a state of the art of the existing topologies'generators. It will be important to identify structural properties of graphs that are interesting in an algorithmic point of view and to provide a state of the art of existing algorithms for recognizing graphs satisfying them.
- Then, the second phase of the project will focus on the design of 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 graphs satisfying these properties. This phase also aims at implementing algorithms pointed out in the state of the art and the proposed new algorithms.

Required background: Algorithmic, graph theory, optimization, computational complexity, programming languages (java, C, python).

Some references:

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