Computation of "good" graph decompositions and applications

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A *tree-decomposition* of a graph [Bodlaender98] is a way to represent it as a tree. More precisely, the associated parameter (the *treewidth*) measures how close a graph is from a tree. When a graph admits a "good" tree-decomposition (i.e., with small treewidth, i.e., the graph is tree-like), many difficult problems (that are NP-complete in general) can be solved in polynomial time. Another similar graph decomposition is the path-decomposition [Bodlaender98]. Beside the algorithmic aspects of such a decomposition, it is closely related to routing problems in telecommunication networks (e.g., WDM and MPLS networks) [Coudert+09].

Therefore, the computation of graphs'decompositions is one of the main current challenge in the computer science area. Obviously, these problems are difficult themselves (NP-complete). During last decade, several approximation algorithms have been designed for computing tree-decompositions of graphs [Bodlaender+95, Even+99,Bouchitté+01,Feige+05]. Moreover, any algorithm for computing tree-decompositions can be turned into an approximation algorithm that computes a path decomposition of a graph.

Main objectives of the internship:

- To implement (in JAVA or PYTHON) the above-mentioned approximation algorithms for computing tree/path-decompositions. In the particular context of routing in telecommunication networks, such a software should allow to estimate performances of existing heuristics [Coudert+09]. This work will of course starts by the study of decompositions themselves to understand the notion;
- To study of the design of new aproximation algorithms or heuristics for computing decompositions. Other interesting perspectives concern the exact computation of decompositions in specific classes of graphs. The algorithmic applications of the obtained decompositions in the context of telecommunication's networks may also be a possible continuation;
- To design algorithms for generating random graphs with a given pathwidth or treewidth (or both). This will be useful to validate the exact and heuristic algorithms.

Required background: graph theory, algorithmic, optimization, computational complexity, JAVA and/or PYTHON

References:

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