Objectifs scientiques et/ou technologique de la collaboration

Despite the simplicity of their definition, graphs are fundamental objects for computer science. On one side, they are the basis of a number of models in many different application areas (networks, biology, molecular chemistry). On the other side, they capture a large part of the computational complexity. A way to understand the graph structure is to study the combinatorial structure of graph classes (or graph properties). This line of research is motivated by the theoretical insight graph classes could provide, as well as the combinatorial essence of some practical problems. Chordal graphs are a good illustration of this fact: they were introduced for their relationship with the Gaussian elimination process, were the first class to be proved perfect and are meanwhile the natural combinatorial object or model in the perfect phylogeny problem. If the algorithmic / complexity picture of the combinatorial optimization problems is pretty well known on the most important graph classes, much less is known on graphs which almost satisfy a desired property Π (that is a small modification yields a new graph satisfying Π), a common situation of most of the graphs arising from practical data-sets as the measure process may create false positives or false negatives.

So, motivated by the identification of some hidden combinatorial structures on experimental data-sets, **graph modification problems** cover a broad range of classical graph optimization problems, among which *edge-completion*, *edge-deletion*, *edge-edition* or *vertex-deletion* problems. Other variants of edge modification problems such as graph sandwich problems have been considered. Of course graph modification problems are not limited to edge modification problems. Combinations of edge and vertex modifications could be considered as well. But not much work has been done involving more complex graph modification operations such as *contraction* or *pivoting*, two operations arising in the context of the graph minor theory.

Unfortunately most of the graph modification problems turns out to be NP-Complete. Moreover, even if the computing power has considerably increased, the continuous growth of the size of datas imposes the use of **moderately exponential time** algorithms to find exact solutions. The goal is to contain the exponential growth of the time complexity as much as possible. When designing **exact exponential-time algorithm**, promoted by the recent survey of Woeginger, the main objective is to minimize the exponential basis of the running time. Clearly, for any polynomial time testable graph property, the corresponding modification problem can be solved in time $O^*(2^m)$ on graph with m edges. It is a natural question to ask for which kind of graph properties the "2^m barrier" can be broken. On some problems the situation is even better: the combinatorial explosion does not depend of the input size n but is rather a function of some parameter k. This observation leads Downey and Fellows to develop the theory of *fixed parameter complexity* to identify the problems that can be solved in time $f(k).n^{O(1)}$. On the theoretical side, new algorithmic paradigms have been developed to build exact-exponential time algorithm algorithms and fixed parameter algorithms, as well as new methods to analyse their running times. Furthermore for some applications, combining fast moderately exponential algorithms with preprocessing methods, namely **kernelization**, is likely to efficiently handle real data-sets.

These closely related approaches are promising in the context of graph modification problems. Our research proposal is manyfold and combines several objectives. On the theoretical side, we'll try to identify generic conditions on graph properties which allows non-trivial exponential time algorithms or efficient kernelizations. We also plan to study the unexplored domain of graph contraction problems. Meanwhile we will develop new methods for more applied problems such as data-clustering.