

Parallel Algorithms for Optimization Problems on Graphs

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A wide range of optimization problems can be expressed with clarity and precision in the pictorial language of graphs. This project focuses on combinatorial optimization problems arising when computing the similarity between two three-dimensional (3D) objects. Such an operation is frequent and can appear in various situations and in very different domains. T

he first particularity of this operation is that the underlying optimization problems are NP-complete and no fast solution to them is known. Furthermore, in this particular case the considered 3D objects are protein structures. This fact by itself is of minor significance in this project and no prior knowledge in bioinformatics is expected. However, one major consequence of this fact is that the underlying problem instances are really very large. The considered operation can be easily modeled in terms of optimization problems in a specific grid alike graph where to each vertex and to each edge are associated weights. Computing the similarity between two objects is then equivalent to finding a maximum weight path in this graph. Although that efficient sequential algorithms have been recently proposed, the need of their parallelization is obvious taking into account the context of their application.

Diverse approaches are possible when parallelizing combinatorial optimization problems. They can be classified as fine or coarse grained, shared or distributed memory. However, not all of them are equally adapted to the existing today multi-core architectures. The main goal of this internship will be to study which level of parallelism is most suited to the above application.

The project will start by reviewing the state of the art. Based on this review, a justified choice will be made for parallelizing the maximum weight path problem. In the second half of the project this choice will be implemented starting from the given sequential algorithm. The efficiency of the parallel algorithm will be illustrated on large benchmarks.

We expect candidates with strong interests in designing parallel algorithms and combinatorial optimization.