



XXV Congresso de Iniciação Científica da Unicamp

October 18 to 20 Campinas | Brazil

25
anos



2017



Uma comparação entre Algoritmos de Aproximação e Heurísticas para Problemas de Produção e Distribuição

Plácido Capp Campos*, Lehlilton Lelis Chaves Pedrosa, Marcelo Pinheiro Leite Benedito.

Abstract

Production and distribution problems are usual in industry, specially if it has a big set of production that might be distributed for numerous clients in different places. This kind of problems are represented as optimization problems and solved using some techniques, as heuristics, that include tabu search, and genetic algorithms, and linear programming, that include LP rounding, primal dual method. This research studies heuristics and approximation algorithms to solve two problems of production and distribution, namely, the JRP (Joint Replenishment Problem) and the FLP (Facility Location Problem). We implement some of the algorithms to solve these problems and compare the results.

Key words:

Technique Comparison, Heuristics, Approximation Algorithms

Introduction

Problems that arise in production and distribution environments usually take a large scale and are very difficult to solve optimally, because it might spend large computational resources. We are interested in NP-hard problems, what means that if we suppose that $P \neq NP$, there are no deterministic polynomial-time algorithms to solve them. Algorithms that do not find the best solution necessarily, but get close to that value, are used to solve this problem in reasonable time. Those are the approximation algorithms, for example those based on integer linear programming, that use the primal-dual and LP-rounding methods.

In the first case, a problem is modeled as ILP, and the dual of the original problem relaxation is explored; in the second case, the relaxed linear problem is solved and then we round the results in some way, to reach a feasible solution to the integer problem. The main reason of obtaining an approximation algorithm is to obtain a guaranty of the solution quality, and understanding how hard the problem is, from the computation point of view.

Other ideas employed in the project of algorithms are the so called heuristics. The advantage is that they are easier to implement as they depend less on the problem. Usually, one used a meta-heuristics, that have a general structure and use different forms of local search. The idea is to look only at a small set of feasible solutions at a time, with the goal of continuously improving the quality of current solution. This project's objective is to study approximation algorithms and heuristics and compare how they behave in two given problems of production and distribution: the Joint Replenishment Problem and the Facility Location Problem.

Results and Discussion

First, we studied some techniques to implement heuristics. We focused on the tabu search and the BRKGA techniques; then, we studied some examples of approximation algorithms, based on primal-dual method and LP-rounding. After this study, four algorithms for each problem were implemented, two heuristics and two

approximation algorithms. We started implemented the heuristic algorithms. To maintain a pattern, and be able to make a reasonable comparison between problems, we implemented two different heuristics for each: tabu search and a BRKGA (Biased Random Key Genetic Algorithm). For the approximation algorithms, again we used two distinct techniques for each problem: the primal-dual approach and a LP-rounding. We are now testing the algorithms against possible benchmarks found in the literature in order to test and compare all the implementations with sensible data.

Conclusions

This studied revealed that the algorithms that are easiest to implement are the BRKGA, as there is basically one routine that is specific to the problem, and the LP-rounding, as it suffices to use an LP solver, and implement a greedy algorithm to obtain a solution. The primal-dual algorithm has shown more complex than the other algorithms, due to many events that might exist, depending on the dual formulation. The advantage of prima-dual algorithm is that they might expose a more involved structure of the problem, as is arguably more efficient (as there is no need to solve an LP). We are currently in the process of testing the algorithms against selected instances, but as, as is the case of the findings of Hoefler's work, we expect heuristics to have better solutions comparing to approximation algorithms, because heuristics can have much more steps than approximation algorithms. They probably will get closer to the optimum value, yet they might take more time too.

Acknowledgement

I thank CNPQ for the PIBIC program, that incentivized my entrance in this undergraduate research, and thank very much my professor Lehlilton Lelis Chaves who teached me a lot, and Marcelo Pinheiro that helped me in this research.

Curtis, M. D.; Shiu, K.; Butler, W. M. e Huffmann, J. C. *J. Am. Chem. Soc.* **1986**, *108*, 3335.

Hoefler, M. *Experimental Comparison of heuristic and approximation algorithms for uncapacitated facility location.* **2002**.