

Combinatorial Optimization in Industrial Applications: From Serial Code Optimization to Grid Computing

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Combinatorial optimization problems are at the core of many industrial applications and processes: Scheduling in car assembly lines [12] and in camera management of Earth observation satellites [3], graph coloring in frequency assignments [5, 1, 10], assignment and location in hub locations [6, 11], vehicle and arc routing in collecting and distribution of goods [7, 2], network design in urban transportation [14], etc.

Most of these optimization problems are *NP*-hard according to the complexity theory. Thus, no polynomial time algorithm is known to solve them, unless $P = NP$ [8]. Furthermore, in industrial contexts, the problems are even harder with very large size instances, many complex constraints and several objectives, and only a few computing time could be dedicated to solve these problems because of slow computing machines in production units or in embedded systems, emergency situations, real-time applications. This is why any improvement we could get from modelling, algorithm, implementation and even parallelism [4, 13, 9] has to be considered.

To support these purposes, two applications will be presented. One is the Transit Network Design (TND) and the second one is the RENAULT¹ car sequencing problem from the French Operations Research and Decision Making-Aid society's² ROADEF challenge 2005. Parallelization techniques and issues will also be addressed through the results of the French ACI-GRID³ Discrete Optimization Challenges on Grid (DOC-G) project⁴.

References

- [1] Fap web - a website about frequency assignment problems. <http://fap.zib.de>.
- [2] M. Ball, T. L. Magnanti, C. L. Monma, and G. L. Nemhauser, editors. *Network Routing*, volume 8 of *Handbooks in Operations Research and Management Science*. Elsevier, 1995.

¹<http://www.renault.com>

²<http://www.roadef.org>

³<http://www.recherche.gouv.fr/recherche/aci/grid.htm>

⁴<http://www.prism.uvsq.fr/DOC-G/>

- [3] N. Bataille, G. Verfaillie, V.-D. Cung, M. Lemaître, and J.-M. Larchiver. Roadef challenge 2003: Management of the mission of earth observation satellites. <http://www.roadef.org>, 2003.
- [4] V.-D. Cung, S. L. Martins, C. C. Ribeiro, and C. Roucairol. *Essays and Surveys in Metaheuristics*, chapter Strategies for the Parallel Implementation of Metaheuristics, pages 263–308. Kluwer Academic Publishers, 2002.
- [5] T. Defaix and V.-D. Cung. Roadef challenge 2001: A frequency assignment problem with polarization constraints. <http://www.roadef.org> and <http://www.fap.ema.fr>. A french article could be found in JNPC2001 proceedings, pp.9-19.
- [6] Z. Drezner, editor. *Facility Location, A Survey of Applications and Methods*, volume XVIII, 571 p. of *Series in Operations Research*. Springer, 1995. ISBN 0387945458.
- [7] H. Eiselt, M. Gendreau, and G. Laporte. Arc routing problems. i: The chinese postman problem. ii: The rural postman problem. *Operations Research*, 43(3):231–242 and 399–414, 1995.
- [8] M. Garey and D. Johnson. *Computers and Intractability, A Guide to the Theory of NP-Completeness*. W.H. Freeman and Company, New York, 1979.
- [9] B. Gendron and T. G. Crainic. Parallel branch-and-bound algorithms: Survey and synthesis. *Operations Research*, 42(6):1042–1066, 1994.
- [10] M. Jiang. Méthodes heuristiques pour le problème du t-coloriage avec ensembles. *RAIRO-RO*, 31(1):1–24, Feb. 1997.
- [11] T. C. Koopmans and M. J. Beckmann. Assignment problems and the location of economic activities. *Econometrica*, 25:53–76, 1957.
- [12] A. Nguyen, Y. Khacheni, and V.-D. Cung. Roadef challenge 2005: A car sequencing problem. <http://www.roadef.org>, 2005. A french article could be found in JFPC2005 proceedings.
- [13] C. Roucairol. In *Parallel and Distributed Algorithms*, chapter Parallel Branch and Bound Algorithms: an Overview, pages 153–163. Elsevier Science Publishers, North-Holland, 1988.
- [14] N. Teypez, A. Barra, and V.-D. Cung. Conception d’un réseau de transport public en utilisant la recherche tabou. In *6ème congrès de la société de Française de Recherche Opérationnelle et Aide à la Décision ROADEF’05*, pages 342–343. Ecole Polytechnique de l’Université de Tours, 2005.