Piston Pump Mobile Unity Tour Problem: An Evolutionary View

Marco César Goldbarg **Elizabeth Ferreira Gouvêa** **Francisco Dantas de M. Neto**

DIMAp, UFRN
Campus Universitário, Lagoa Nova
Natal, Brazil, 59 072-084

Abstract

This work presents a version of the Piston Pump Unity Tour Problem. The problem is solved by three evolutionary algorithms designed according to genetic and transgenetic approaches.

1 INTRODUCTION

A Piston Pump Mobile Unity, PPMU, is a vehicle used in the exploitation of onshore petroleum fields to recover the oil of some wells that have not enough energy to lift the oil to the surface. The times needed for the PPMU to move from a well to another one and to install and uninstall its equipment depend on factors such as conditions of the roads, well characteristics and the PPMU operator's experience. These variables can be empirically determined by means of the history of operations. The objective is to determine a sequence of visits of the PPMU to the wells such that the oil volume recovered is maximized, given a certain working period. In this version of the Piston Pump Mobile Unity Tour Problem, PPP, a well can not be considered more than once in the same working period. The PPMU working period can contain more than one tour. Three evolutinary algorithms were implemented to solve the Piston Pump Mobile Unity Tour Problem (PPP): a genetic and two transgenetic ones.

2 ALGORITHMS

For the PPP a chromosome is a sequence of wells that will be visited by the PPMU. The contribution of a well to the fitness of a chromosome is its volume divided by the distance between the well and the last position of the PPMU. The fitness of a chromosome is the summation of the contributions of all the wells in that chromosome. The Genetic Algorithm used the roullete wheel method to select the parents of the next generation. Given two parents, two offspring are generated by fixing one parent and trying to insert one well of the other parent in the sequence of visits of the former. Mutation is based on the wells with low occurrence in the population. One of those wells is chosen at random and inserted into a chromosome.

Computational Transgenetics, CT, is a multiagent proposal that aims at managing the process of information insertion in an evolutionary context. CT considers the epigenetic, the sexual reproduction and the prokaryotic recombination paradigms of evolution. CT provides two classes of evolutionary algorithms: the Extra-Intracellular Transgenetic Algorithms, EITAs (Goldbarg and Gouvêa, 2001), and Proto-Gene (Gouvêa and Goldbarg, 2001). CT infiltrates information in an evolutionary process by means of transgenetic agents. A transgenetic agent may be composed by one or more memes and an operating method. A meme is a proposal to organize a given DNA segment. The memes used on the transgenetic algorithms were pairs of wells. There were generated $n/2$ pairs of wells, where n is the number of wells of an instance. The wells were sorted by oil volume in non crescent order and, to generate a pair, two wells were chosen at random from the first half of the wells, that is the half with highest volumes.

3 COMPUTATIONAL EXPERIMENTS

The approach used in the transgenetic algorithms showed a better performance than the Genetic Algorithm. The ProtoG algorithm presented the better performance for all the instances generated. Furthermore, real PPP problems of a brazilian petroleum company were also solved by the three algorithms presented and, again, ProtoG found the best solutions.

Acknowledgments

This research was funded by Finep/CTPetro and ANP/RH program.

References

M. C. Goldbarg and E. F. Gouvêa (2001). Extra-Intracellular Transgenetic Algorithm, *GECCO 2001 Proceedings of the Genetic and Evolutionary Computation Conference*, 762. San Francisco, CA: Morgan Kaufmann.

E. F. Gouvêa and M. C. Goldbarg (2001). ProtoG: a Computational Transgenetic Algorithm, In *Proceedings of MIC 2001 – 4th Metaheuristics International Conference*, Porto, Portugal, 625-631.