- **Title:** Integration of machine learning methods in metaheuristics
- **Supervisors** : - Prof. L. Idoumghar (UHA, IRIMAS),
  Email: lhassane.idoumghar@uha.fr
  Personal web page: http://www.mage.fst.uha.fr/idoumghar/
  - Prof. A. Koukam (UTBM, CIAD),
  Email: abder.koukam@utbm.fr
  Personal web page: http://www.multiagent.fr/People:Koukam_abderrafiaa

Description

The design of efficient optimization methods is a major concern for many industries (automotive, aerospace, broadcast, etc). Indeed, in recent years, many exact methods and heuristics, increasingly efficient, have been proposed to solve difficult problems. Metaheuristics are an interesting class of approaches to solve large-scale problems. Indeed, their diversity enables them to be adapted to different types of problems. To take advantage of this variety, many hybrid methods, for example using two metaheuristics, exist in the literature. Unfortunately, at present, this type of hybridization is mainly achieved statically and the parameter setting is mainly performed experimentally. Thus, one of the limitations of this type of methods relates to the set of hybridization parameters to be defined (how to combine two approaches, when to instantiate a particular approach, etc). Through this PhD thesis, our objective is to answer these questions by developing new metaheuristics that incorporate one or more machine learning methods in order to better guide the search towards a better solution in the search space, often exponential. Transport and mobility related applications will be used to test and evaluate this approach.

References

1. D. Meignan, A. Koukam, J.C. Creput. "Coalition-based metaheuristic: a self-adaptive metaheuristic using reinforcement learning and mimetism". Journal of Heuristics,16 (6). 2010.
2. Jiawei ZHU, Fabrice LAURI, Abderrafiaa KOUKAM and Vincent HILAIRE. “A Hybrid Intelligent Control System based on PMV Optimization for Thermal Comfort in Smart Buildings”. In ICCSAMA, 2015.
3. L. Idoumghar, N. Chérin, R. Roche, A. Miraoui. "Hybrid ICA-PSO algorithm for continuous optimization", Journal of Applied Mathematics and Computation, vol. 219, no. 24, pp. 11149-11170, 2013.
4. E. M. Cochrane, J. E. Beasley. "The co-adaptive neural network approach to the Euclidean Travelling Salesman Problem", Neural Networks, vol. 16, no. 10, pp. 1499-1525, 2003.
5. M. Essaid, M. Brévilliers, J. Lepagnot, L. Idoumghar and D. Fodorean, "Hybrid parameter adaptation strategy for differential evolution to solve real-world problems," 2019 IEEE Congress on Evolutionary Computation (CEC), Wellington, New Zealand, 2019, pp. 3030-3036.
6. and H. Rakhshani, M. Brevilliers, L. Idoumghar, J. Lepagnot, E. Keedwell, "A Novel Population Initialization Method Based on Support Vector Machine," 2018 IEEE International Conference on Systems, Man, and Cybernetics (SMC), Miyazaki, Japan, 2018, pp. 751-756.

Work plan

This work consists of the following phases:

- Write a state of the art about machine learning methods and metaheuristics.
- Study the exploration process of the hybrid methods developed by our team in order to extract useful information/knowledge.
- Propose new hybrid methods incorporating learning mechanisms.
- Propose massively parallel versions.
- Validate the proposed approaches on academic and industrial problems studied by our team.

Prerequisites

- The candidate must have a Master or equivalent in computer science or applied mathematics. The candidate must have good knowledges in the following areas: metaheuristics, machine learning, GPU programming.
- Programming language: C++.
- Good knowledge of development under Linux.
- The candidate must be fluent in English.