PhD Position

Localization: LIMOS, Clermont-Ferrand (France)
Title: Hybridization of methods of Machine Learning and Operation Research for scheduling and routing problems

PhD Advisors: JP Gayon, Ph. Lacomme, N. Tchernev,

Candidate skill:
- Graduated from a school or a master
- Basic training in Optimization (including linear programming, scheduling, routing, graph theory)
- Correct level in programming (C, ...)
- Basic knowledge of Python

Description of research work:

The subject focuses on transportation problem in multi-configuration workshops with the objective to tackle the fleet of vehicles efficiently. A configuration can be defined at a skim that defined the operation duration and one operation is the processing of one job on a machine, with a duration that depends on the resource assignment.

During the research, different resolution schemes could be investigated including but not limited to linear programming, constraint programming and any methods of Artificial Intelligence that could be of interest for solving.

The sub-problems could include:
- Management of configuration;
- The quality of service as an extension of the famous work of Cordeau et Laporte (2003), considering extra delay between loading and unloading operation;
- The management of vehicle recharging periods (modelized by break) with constraint that are extensions of maximal time lags, and partially splitted breaks as defined in the legal constraint of the transport;
- The transportation time variation depending on the access time to routes which could required a new definition of shortest time where the arc cost could be time dependant.

The transportation problem falls into the family of DARP problems (or Pick-Up and Delivery problems) and by consequence a solution is an ordered sequence of loaded and unloaded transport operation.

The originality of the resolution procedures should be based on the connection with elements of the Artificial Intelligence type. The objective may be to understand how a priori knowledge can guide algorithms and how to acquire and store this knowledge. The latest major advances in SAT-type PPC solvers are pushing in this direction.

Currently few researchers have reached significant results and mainly concern routing problems. There are few publications and the major ones are the Kenneth Sorensen’s researches.

The reference article is that published in 2019 in the journal Computers and Operations Research.
From an Artificial Intelligence point of view, the scientific and technical obstacles to overcome are as follows:

- Characterize the differences between quality solutions and poor quality solutions by analyzing the structure of the solutions or more precisely the structure of the objects coding the solution. For a scientific point of view, the problem is to analyze and to understand the relation between the data of the problem (processing time ...) and the vectors giving, after decoding, a high quality solution. This probably involves doing post-mortem analyzes of the solutions evaluated during the resolution, and then defining a powerful algorithmic approach to investigate parallel execution to proposed an algorithm that not impact the computation time of an iteration.

- Dynamically, during the optimization process, identify the information allowing to define a local search taking advantage of global information. The notion of global information could be defined as a set of patterns to be favored at a given time while integrating the fact that these patterns are partial information based only on the first iterations of the method. The technical difficulty then consists in impacting the speed of convergence without falling prematurely into local minima.

- Definition of mechanisms for dynamic adaptation of local research movements in the trend of (Thevenin et al., 2019) with the notion of LVNS (Learning Variable Neighborhood Search). The basic approaches could take advantage of dynamic probabilities of executing a specific (Chassaing et al., 2016) and to dynamically update these probabilities.

- Define mechanisms to analyze a priori the structure of a coding element and classify it (without carrying out its evaluation) possibly as not promising and thus avoid costly and unnecessary evaluations. Preliminary work presented in conference by D. Vigo is based on neural networks. Here we plan to study regression mechanisms, neural networks and possibly extend the concept of convolution.

To candidate, constact:

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