

PhD thesis proposal

Title: Study of combinatorial properties and their impact in evolutionary optimization

Supervisor: Vincent Vajnovszki (Professor)

Co-supervisors: Jean-Luc Baril (Professor), Wahabou Abdou (Associate Professor)

Contacts:

Vincent Vajnovszki: vvajnov@u-bourgogne.fr

Jean-Luc Baril: barjl@u-bourgogne.fr

Wahabou Abdou: wahabou.abdou@u-bourgogne.fr

Address:

Université de Bourgogne - Franche-Comté

Laboratoire LE2I

9, avenue Alain Savary

21078 DIJON

Keywords: Combinatorics, optimization, patterns, permutations, Lehmer code, evolutionary computation

Context and Objectives

A pattern in a permutation or a word witnesses regularities in it, and there is an intimate tie between pattern occurrences in permutations and statistics: the number of occurrences of a pattern becomes naturally a statistic, and many well-known statistics on permutations or words can be re-expressed in terms of pattern containment, and pattern replacement yields to constructive bijections between combinatorial classes.

Recently [1,2,8], in the combinatorial community there is a great deal of investment in pattern-based statistics on permutations and words due to its theoretical and practical interest. Indeed, statistics bring meaning to large size data, hence their potential applications in bioinformatics or crowd computing for example. In the last years many new results were obtained, appropriate techniques were developed, and new unexpected equidistributions of some statistics were highlighted. However, many problems remain open, many generalizations and unifying approaches remain to be developed and applications to be identified.

Studying a pattern in a permutation is particularly interesting in many transportation optimization problems [4]. Vehicle tours are represented by

a permutation. In evolutionary optimization processes, it is important to study the transmission of patterns over generations [3,6]. As a result, the way the permutations are encoded is important [5] and some works in the literature are interested in the impact of solutions' encoding on the performances of optimization algorithms [7].

The aim of this PhD subject is to enhance known results and generalize them to other combinatorial classes, to introduce a general approach (based on permutation codes for instance), but above all to obtain results concerning new statistics and new combinatorial classes, and study their impacts in evolutionary optimization processes.

The thesis will take place in the CombNet team of Laboratory LE2I of University of Burgundy (Dijon - France)

Requirements: Background in combinatoric and optimization techniques. Knowledges in evolutionary computation. Programming skills.

References

- [1] J.-L. Baril, Statistics-preserving bijections between classical and cyclic permutations, *Information Processing Letters*, 2013, Vol. 113, pp. 17-22.
- [2] J.-L. Baril, V. Vajnovszki, A permutation code preserving a double Eulerian bivariate, *Discrete Applied Mathematics*, 2017, 224, pp. 9-15.
- [3] L. Djerdj, M.-C. Portmann, and P. Villon, Performance analysis of permutation crossover genetic operators, *Journal of Decision Systems*, 1996, Vol. 5(1-2), pp. 157–177.
- [4] M. Gendreau, A. Hertz and G. Laporte, New insertion and postoptimization procedures for the traveling salesman problem, *Operations Research*, 1992, Vol. 40(6), pp. 1086–1094.
- [5] D.H. Lehmer, Teaching combinatorial tricks to a computer, in: *Proc. Sympos. Appl. Math.*, Vol. 10, Amer. Math. Soc, 1960, pp. 179-193.
- [6] M. Mehdi, *Parallel Hybrid Optimization Methods for Permutation Based Problems*, October, 2011, PhD Thesis, Distributed, Parallel, and Cluster Computing [cs.DC]. Univ. Lille 1, France.
- [7] H. Mohammed Ali, C. Bloch, W. Abdou, P. Chatonnay and F. Spies, *Behaviour Study of an Evolutionary Design for Permutation Problems*, 2018, London, United Kingdom, Third International Congress on Information and Communication Technology (ICICT 2018).
- [8] V. Vajnovszki, Lehmer code transforms and Mahonian statistics on permutations, 2013, *Discrete Mathematics*, 313, pp. 581-589.