Fundamentals for Real World Applications of Metaheuristics:
The vehicular case
Ministerio de Economía y Competitividad (Spain)
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Executive Summary

TITLE: **D2.2.2: Complexity analysis of developed algorithms.**

PAPERS RELATED:

- F. Chicano, D. Whitley, A. M. Sutton, Efficient Identification of Improving Moves in a Ball for Pseudo-Boolean Problems, GECCO 2014 (accepted for publication)

ABSTRACT: Hill climbing algorithms are at the core of many approaches to solve optimization problems. Such algorithms usually require the complete enumeration of a neighborhood of the current solution. In the case of problems defined over binary strings of length n, we define the r-ball neighborhood as the set of solutions at Hamming distance r or less from the current solution. For $r \ll n$ this neighborhood contains $\Theta(n^r)$ solutions. In this work efficient methods are introduced to locate improving moves in the r-ball neighborhood for problems that can be written as a sum of a linear number of subfunctions depending on a bounded number of variables. NK-landscapes and MAX-kSAT are examples of these problems. If the number of subfunctions depending on any given variable is also bounded, then we prove that the method can explore the neighborhood in constant time, despite the fact that the number of solutions in the neighborhood is polynomial in n. We develop a hill climber based on our exploration method and we analyze its efficiency and efficacy using experiments with NKQ-landscapes instances.

GOALS:

1. A practical application of landscape theory to the optimization of pseudo-Boolean functions.

CONCLUSIONS:

1. We have provided an algorithm to efficiently identify improving moves in a Hamming ball of radius r around a solution of a k-bounded pseudo-Boolean optimization problem that can be written as a sum of subfunctions.
2. We proved that, under some distributions of variables, the time required for the identification of improving moves is independent on the size of the problem, n, and exponential in r. We designed a next ascent algorithm based on our algorithm for updating the Score vector that tracks potential improving moves.
3. The empirical results on NKQ-landscape instances show that increasing r improves the quality of the solutions found by next ascent local search.

RELATION WITH PAST DELIVERABLES: none

OTHERS: W. Chen, D. Whitley, D. Hains, and A. Howe. Second order partial derivatives for NK-landscapes. In *Proceeding of GECCO*, pages 503–510, New York, NY, USA, 2013. ACM.