**Global optimization algorithm that uses decision trees to find local extrema**

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**Abstract:** The paper considers the algorithms for solving the multidimensional global optimization problems using decision tree to reveal the attraction regions of the local minima. We suppose, that the target function is defined as a “black box” and satisfied Lipschitz condition with unknown constant. We propose a method for selecting the local extrema neighborhood of the target function based on analysis of accumulated search information using machine learning methods. This allows us to make a decision to run a local method, which can speed up the convergence of the algorithm. The proposition was confirmed by the results of numerical experiments demonstrating the speedup when solving a series of test problems.

**Keywords:** Global optimization, multiextremal functions, parallel computing, decision tree.

**References:**

1. M. Ferreiro, J. A. Garcia, J. G. Lopez-Salas, and C. Vazquez, “An efficient implementation of parallel simulated annealing algorithm in gpus,” Journal of global optimization, vol. 57, no. 3, pp. 863–890, 2013.
2. J. M. Garcia-Martinez, E. M. Garzon, and P. M. Ortigosa, “A gpu implementation of a hybrid evolutionary algorithm: Gpuego,” Journal of super-computing, vol. 70, no. 2, pp. 684–695, 2014.
3. W. B. Langdon, “Graphics processing units and genetic programming: an overview,” Soft Computing, vol. 15, no. 8, pp. 1657–1669, 2011.
4. Yu. G. Evtushenko, V. U. Malkova, A. A. Stanevichyus, “Parallel global optimization of functions of several variables,” Computational Mathematics and Mathematical Physics, vol. 49, no. 2, p. 246–260, 2009.
5. J. He, A. Verstak, L. T. Watson, and M. Sosonkina, “Design and implementation of a massively parallel version of direct,” Computational optimization and applications, vol. 40, no. 2, pp. 217–245, 2008.
6. R. Paulavicius, J. Zilinskas, and A. Grothey, “Parallel branch and bound for global optimiza-tion with combination of lipschitz bounds,” Optimization methods and software, vol. 26, no. 3, pp. 487–498, 2011.
7. R.G. Strongin, V.P. Gergel, V.A. Grishagin, K.A. Barkalov , Parallel Computations in Global Optimization Problems. Izd. Mosk. Gos. Univ., 2013.
8. V. P. Gergel, “A global optimization algorithm for multivariate functions with lipschitzian first derivatives,” Journal of Global Optimization, vol. 10, no. 3, pp. 257–281, 1997. 12
9. D. Himmelblau, Applied Nonlinear Programming. Mir Publishers, 1975.
10. J. Nelder and R. Mead, “A simplex method for function minimization,” Computer Journal, vol. 7, no. 4, pp. 308–313, 1965.
11. S. Brahmbhatt, Practical OpenCV (Technology in Action). New York: Apress, 2013.
12. “Opencv (open source computer vision) documentation,” (accessed: 10 July 2022). [Online]. Available: https://docs.opencv.org/4.x/dc/dd6/ml\_intro.html
13. Sysoyev, K. Barkalov, V. Sovrasov, I. Lebedev, and V. Gergel, “Globalizer – a parallel software system for solving global optimization problems,” Lecture Notes in Computer Science, vol. 10421, no. LNCS, pp. 492–499, 2017.
14. M. Gaviano, D. Lera, D. E. Kvasov, and Y. D. Sergeyev, “Software for generation of classes of test functions with known local and global minima for global optimization,” ACM Transactions on Mathematical Software, vol. 29, pp. 469–480, 2003.
15. Ya.D. Sergeev, D.E. Kvasov, Diagonal Global Optimization Methods. Fizmatlit, 2008.
16. Y. D. Sergeyev and D. E. Kvasov, “Global search based on efficient diagonal partitions and a set of lipschitz constants,” SIAM Journal on Optimization, vol. 16, no. 3, pp. 910–937, 2006.

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