Multiobjective genetic discovery of driving strategies

Erik Dovgan[1,2]

[1] Department of Intelligent Systems, Jožef Stefan Institute, Ljubljana, Slovenia

[2] Jožef Stefan International Postgraduate School (New Media and E-Science, 2nd year)

erik.dovgan@ijs.si

Vehicle driving consumes time and energy (fuel, electricity etc.). Usually both have to be minimized. Minimizing the consumption of one of them leads to increasing the consumption of the other. To find driving strategies that take into consideration both objectives, we have implemented a multiobjective genetic algorithm that constructs driving strategies as sets of rules. Optimal sets of rules consist of non-dominated solutions and therefore cannot be sorted based on quality since each solution represents a particular trade-off between the two objectives. The final strategy selection is done by the user who uses higher-level information to select the most preferred strategy from the found best solutions.

To test the strategies, we implemented a vehicle simulator. It is defined with the engine, transmission, aerodynamics, braking and wheel characteristics. It simulates driving on a predefined route that consists of segments. Each segment is defined with its length, inclination, radius and velocity limit. Vehicle driving is controlled with a strategy consisting of a set of rules. Each rule has the following form: IF vehicle characteristics INSIDE interval1 AND segment characteristics INSIDE interval2 THEN USE throttle percentage AND gear OR braking percentage.

The implemented multiobjective genetic algorithm is based on NSGA-II [1]. It has the characteristics of genetic algorithms [2] as follows. It randomly initializes a set of driving strategies. Then these strategies are improved over generations where in each generation pairs of strategies are randomly selected, their information is exchanged, their rules are randomly changed, a randomly selected rule is removed and a randomly created rule is added, and the strategies are finally evaluated and added to the set of strategies [3]. This is done in such a way that each strategy is selected once on average in each generation. In addition to these classical genetic algorithm mechanisms, the NSGA-II has dedicated mechanisms in order to meet the multiobjective algorithm requirements: in addition to minimization of the objectives, it preserves the diversity of the strategies with respect to the objectives. This is done using the non-dominated sorting and the crowding distance mechanisms known from the NSGA-II.

Using the described algorithm, we performed preliminary numerical experiments in multiobjective discovery of driving strategies for several predefined simple routes [4]. The results in the form of nondominated sets of solutions are promising and stimulative for further investigation in this problem domain. Future work will include improvements of the algorithm efficiency, its testing on the routes defined with real data, and comparison of our results with the results of other algorithms.

References:

[1] K. Deb, S. Agrawal, A. Pratap, and T. Meyarivan. A fast elitist non-dominated sorting genetic algorithm for multi-objective optimisation: NSGA-II. *Proceedings of the 6th International Conference on Parallel Problem Solving from Nature*, pp. 849–858, 2000.

[2] A. E. Eiben and J. E. Smith. *Introduction to Evolutionary Computing*. Springer, 2003.

[3] K. A. De Jong. *Evolutionary Computation: A Unified Approach*. MIT Press, 2006.

[4] E. Dovgan, M. Javorski, and B. Filipič. A Multiobjective Genetic Algorithm for Discovering Car Driving Strategies. Technical Report IJS-DP 10402. Jožef Stefan Institute, Ljubljana, 2010.